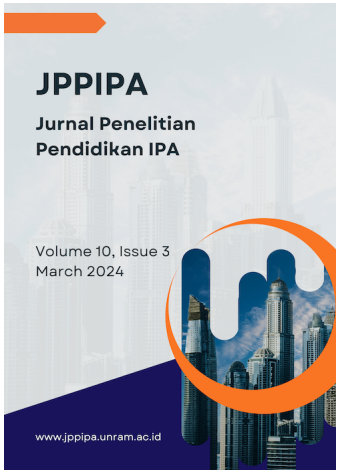
Twenty-Eighth Edition

Jurnal Penelitian Pendidikan IPA (JPPIPA), Online ISSN: **2407-795X**, Print ISSN: **2460-2582**



March

Vol. 10 No. 3 (2024)

Twenty-seventh Edition

Jurnal Penelitian Pendidikan IPA (JPPIPA), Online ISSN: **2407-795X**, Print ISSN: **2460-2582**

February

Vol. 10 No. 2 (2024)

Twenty-sixth Edition

Editorial Team

Editor in Chief

- **Aris Doyan,** ID SCOPUS: **37461206900,** University Of Mataram, Indonesia

Managing Editor

- **Hamidi,** ID SCOPUS: **57216950915,** Univerity Of Mataram, Indonesia

Editorial Board

- **David Todd Campbell,** ID SCOPUS: **25633499100,** University Of Connecticut, United States
- **Keith S Taber,** ID SCOPUS: **7006375190,** University Of Cambridge, United Kingdom
- **Muhammad Zurhalqi,** Vistula University, Poland.
- **Muhammad Aziz**, ID SCOPUS: **56436934500**, University Of Tokyo, Japan
- **Jakrapong Kaewkhao,** SCOPUS ID: **23974520300**; Nakhon Pathom Rajabhat University, Thailand
- **Firdaus Ali,** SCOPUS ID: **57197439497,** Jamia Millia Islamia (A Central University), New Delhi, India
- **Muhammad Roil Bilad,** SCOPUS ID: **36999741400**, Universiti Brunei Darussalam, Brunei Darussalam.
- **Azlan Kamari,** ID SCOPUS: **6507553589,** Universiti Pendidikan Sultan Idris, Malaysia
- **Mohd Mustafa Awang Kechik,** ID SCOPUS: **18037839400,** Universiti Putra Malaysia, Malaysia
- **Baba Musta** ID SCOPUS: **23976431800,** Universiti Malaysia Sabah, Malaysia
- **Ali AL-Mokaram** ID SCOPUS: **57196001359,** Mustansiriyah University, Iraq
- **Khalid Ahmed Rabaeh** ID SCOPUS: **24329973600,** Hashemite University, Jordan

Layout Editor

Assistant Editors

JPPIPA JURNAL PENELITIAN PENDIDIKAN IPA

Jurnal Penelitian Pendidikan IPA

ISSN: 2407-795X , 2460-2582

Journal title	: **Jurnal Penelitian Pendidikan IPA**
Initials	: **JPPIPA**
Editor-in-chief	: **Prof. Aris Doyan, Ph.D**
Online ISSN	: **2407-795X**
DOI Prefix	: **10.29303/jppipa**
Indexing	: **Google Scholar and view more**
Peer Review Process	: **blind-Review**
Frequency	: **Monthly**
Publisher	: **Postgraduate University of Mataram**
Association	: **Perkumpulan Pendidik IPA Indonesia**
Citation Analysis	: **Dimensions, Google Scholar**
Language	: **English**

Jurnal Penelitian Pendidikan IPA contains scientific articles form of research results that include science, technology, and teaching in the field of science. **Jurnal Penelitian Pendidikan IPA** is

published monthly. Authors across the globe are welcome to submit their research papers in the prestigious journal fulfilling the requisite criterion.

Jurnal Penelitian Pendidikan IPA provides immediate **OPEN ACCESS** to its content on the principle that making research freely available to the public supports a greater global exchange of knowledge.

Jurnal Penelitian Pendidikan IPA index by: **|Crossref| |Sinta DIKTI| |Indonesian Public Index (IPI)| |Google Scholar| |Indonesian One Search| |Bielefeld Academic Search Engine (BASE)| |Index Copernicus International (ICI) World of Journals| |PKP Index| |Academic Recource Index| |Mendeley| |Garuda Ristekdikti| More...**

Jurnal Penelitian Pendidikan IPA promotes research in the field of science and Science Education with particular respect to Indonesia, but not limited to authorship or topical coverage within the region. Contributions are expected from scientists, educators, senior researchers, project managers, research administrators, and students at advanced stages of their research. To be published in **Jurnal Penelitian Pendidikan IPA**, a rigorous review process will be done.

The editorial contents and elements that comprise the journal include:

- Theoretical articles
- Empirical studies.
- Case studies
- Systematic Literature Review.

The editorial board welcomes manuscripts from Science and Science Education. The scopes of **Jurnal Penelitian Pendidikan IPA** are:

1. Science (Chemistry, Physics, and Biology)
2. Science Education
3. Chemistry Education
4. Physics Education

5. Biology Education
6. Education Technology
7. Application science (Chemistry, Physics and Biology)
8. Model, Methods, and Strategies of Learning in science education

Nationally Accredited

EDITORIAL TEAM

REVIEWERS

FOCUS & SCOPE

PUBLICATION ETHICS

INDEXING AND ABSTRACTING

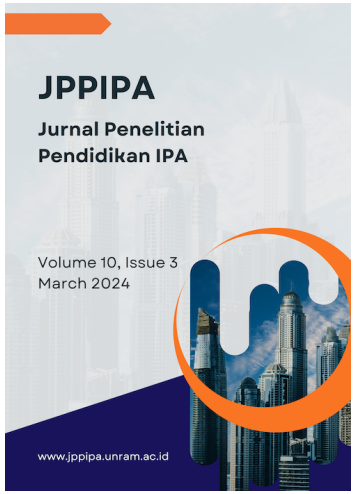
ARCHIVING INFORMATION

SCOPUS CITATION ANALYSIS

Journal Template

JPPIPA JURNAL PENELITIAN PENDIDIKAN IPA

Vol. 10 No. 3 (2024): March



Twenty-seventh Edition

Jurnal Penelitian Pendidikan IPA (JPPIPA), Online ISSN: **2407-795X**, Print ISSN: **2460-2582**

DOI: 10.29303/jppipa.v10i3

Research Articles | **Review** | **Published:** 2024-04-16

The Use of Inquiry Learning Model on Plant Growth and Development Material to Improve Students' Science Process Skills

Ani M Hasan 982-990

DOI: 10.29303/jppipa.v10i3.4874
Statistics: 77 | 114

Citations 0

Framz Hardiansyah , Ali Armadi , Muhammad Misbahudholam AR , Moh. Wardi 1159-1166

DOI: 10.29303/jppipa.v10i3.5661
Statistics: 44 | 22

PDF

Seismic Vulnerability Distribution in the Central Area of Surabaya City

Dzikrullah Akbar , Mohammad Syamsu Rosid , Aina Najwa Darmanto 1167-1174

DOI: 10.29303/jppipa.v10i3.6761
Statistics: 11 | 13

PDF

Ricosre Model with Question Formulation Technique (QFT): Enhancing Students' Higher Order Thinking Skills (HOTS) and Science Literacy

Irdalisa , Budhi Akbar , Tuti Marjan Fuadi , Maesaroh , Eka Kartikawati 1175-1178

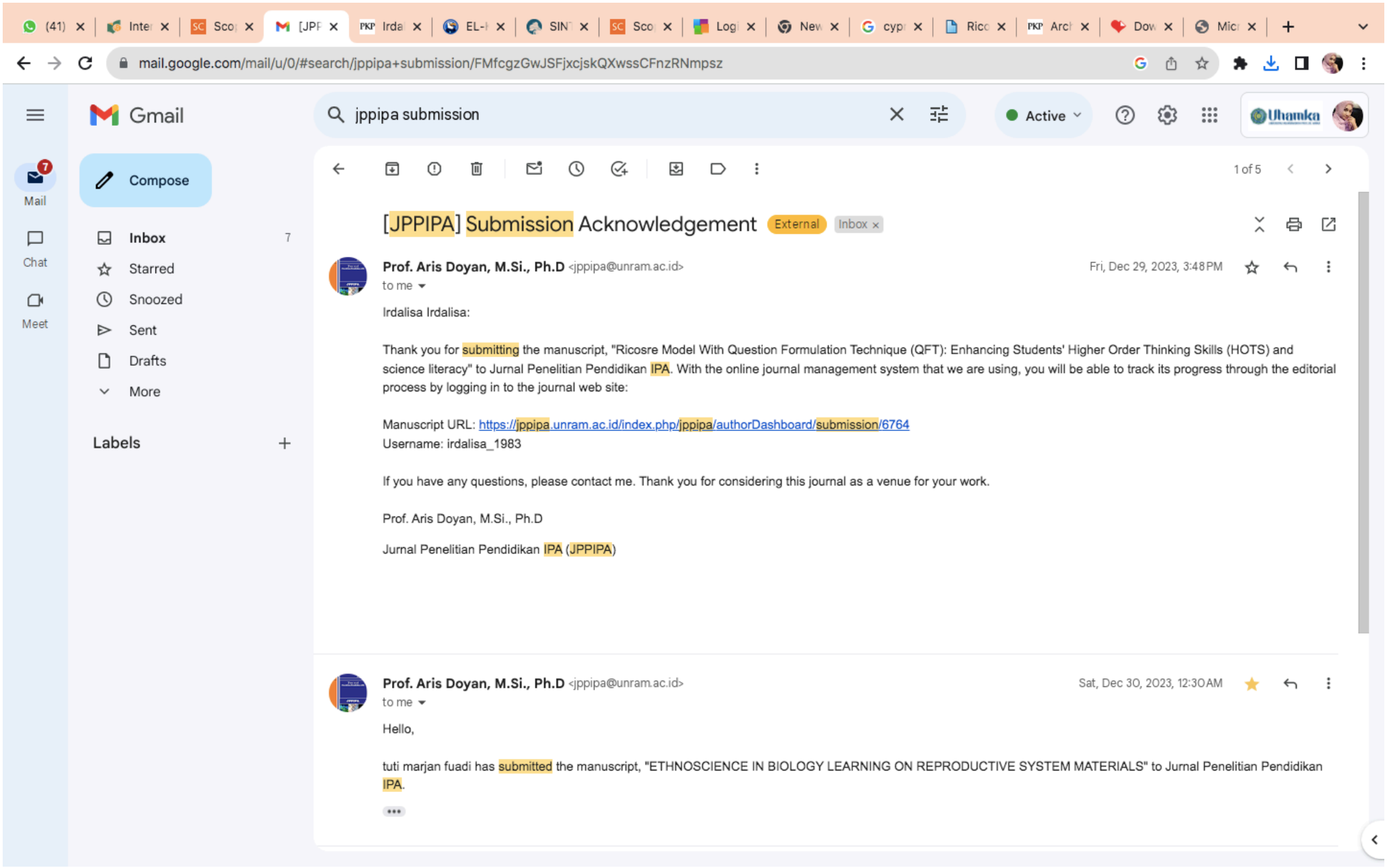
DOI: 10.29303/jppipa.v10i3.6764
Statistics: 13 | 9

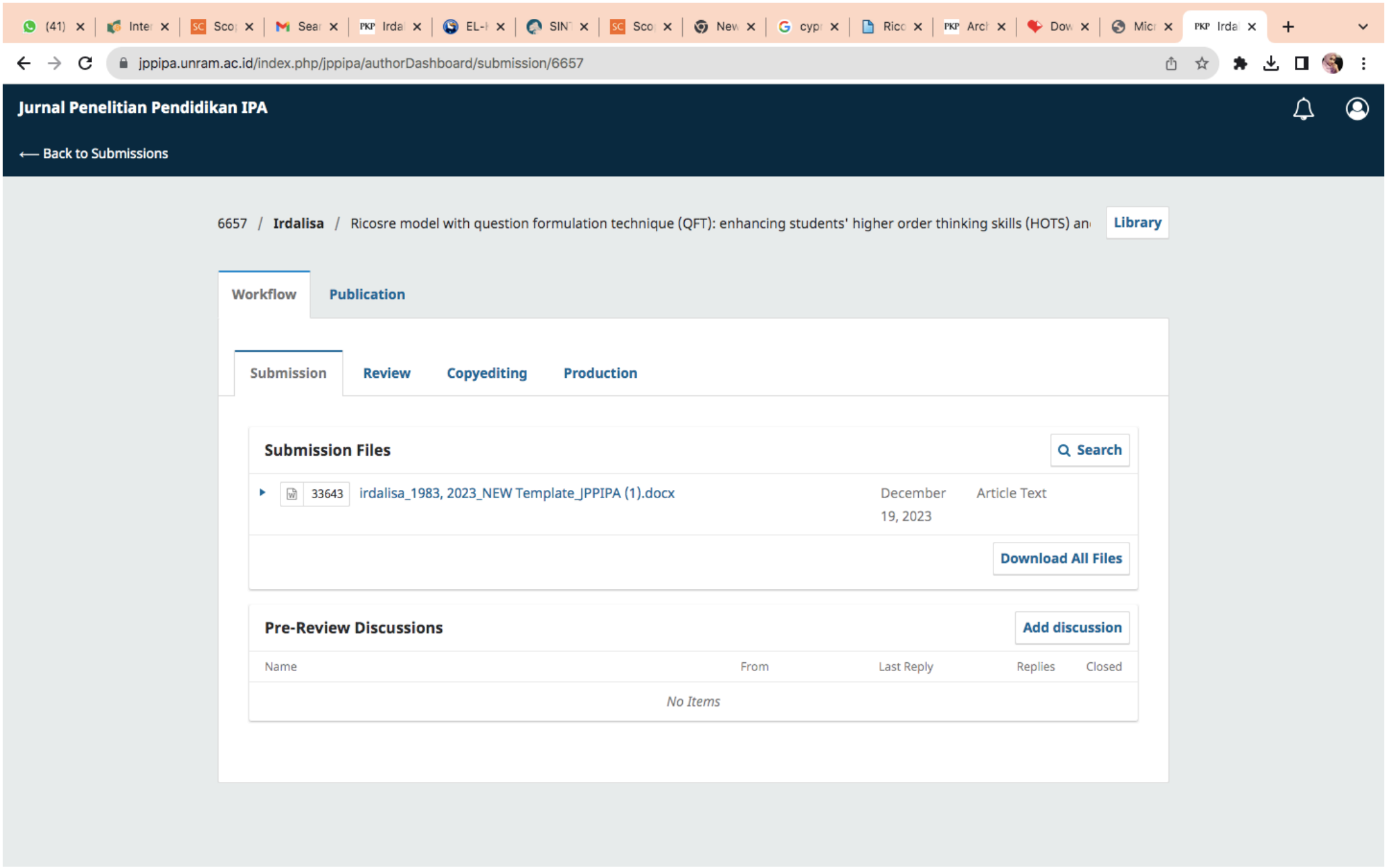
PDF

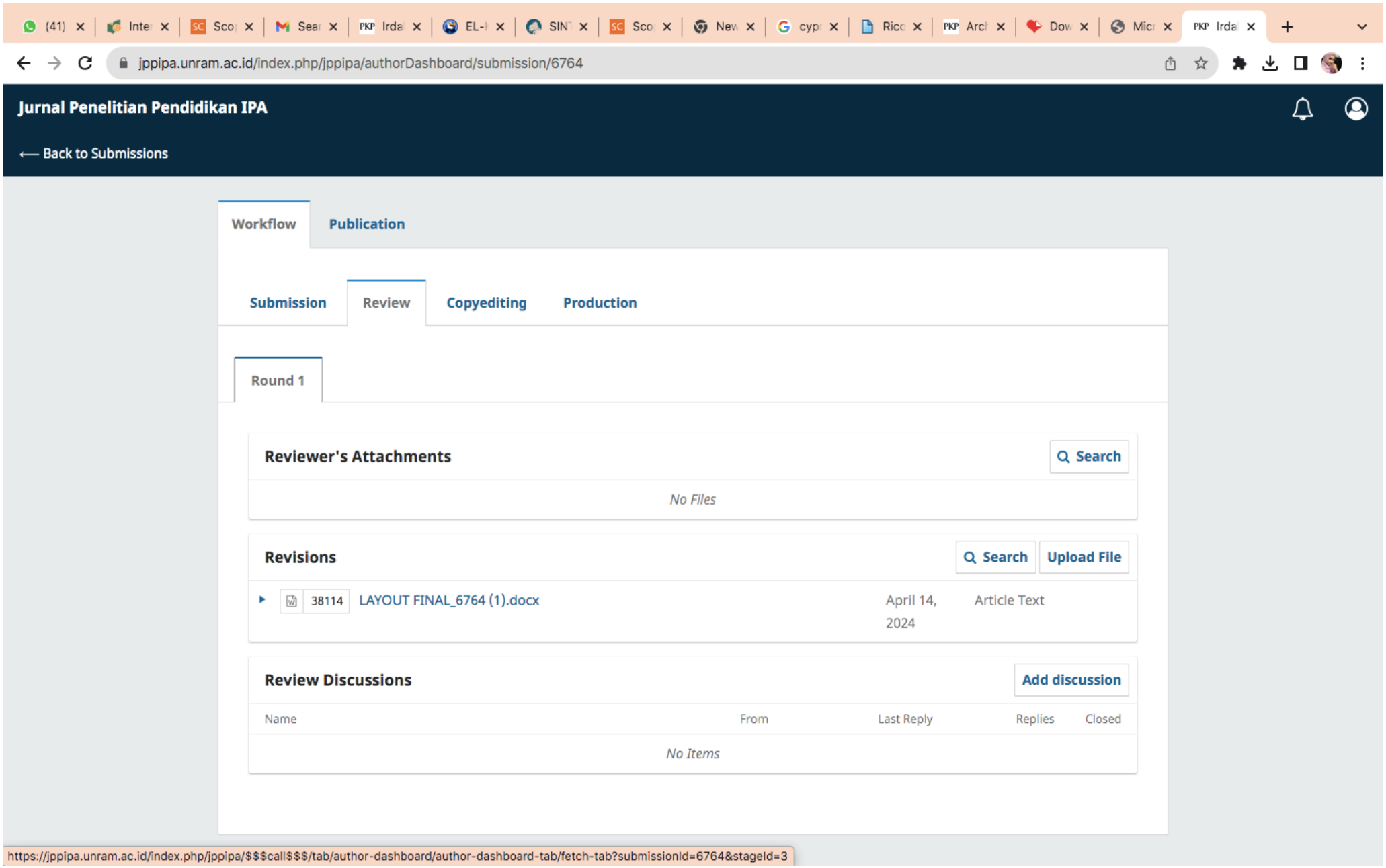
Development of Video Learning Materials for Asertification of Communication Skills in Students

Yonny Chintya Hasty Syafutry , Muhammad Ali , Bunga Ayu Wulandari 1179-1187

DOI: 10.29303/jppipa.v10i3.6967
Statistics: 7 | 11


jppipa submission
Active
Compose
Inbox 7
Starred
Snoozed
Sent
Drafts
More
Labels
1 of 5
[JPPIPA] Submission Acknowledgement
External
Inbox ×
Prof. Aris Doyan, M.Si., Ph.D <jppipa@unram.ac.id>
to me
Fri, Dec 29, 2023, 3:48 PM
Irdalisa Irdalisa:
Thank you for submitting the manuscript, "Ricosre Model With Question Formulation Technique (QFT): Enhancing Students' Higher Order Thinking Skills (HOTS) and science literacy" to Jurnal Penelitian Pendidikan IPA. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:
Manuscript URL: https://jppipa.unram.ac.id/index.php/jppipa/authorDashboard/submission/6764
Username: irdalisa_1983
If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.
Prof. Aris Doyan, M.Si., Ph.D
Jurnal Penelitian Pendidikan IPA (JPPIPA)
Prof. Aris Doyan, M.Si., Ph.D <jppipa@unram.ac.id>
to me
Sat, Dec 30, 2023, 12:30 AM
Hello,
tuti marjan fuadi has submitted the manuscript, "ETHNOSCIENCE IN BIOLOGY LEARNING ON REPRODUCTIVE SYSTEM MATERIALS" to Jurnal Penelitian Pendidikan IPA.


jppipa.unram.ac.id/index.php/jppipa/authorDashboard/submission/6657
Jurnal Penelitian Pendidikan IPA
Back to Submissions
6657 / Irdalisa / Ricosre model with question formulation technique (QFT): enhancing students' higher order thinking skills (HOTS) an
Library
Workflow
Publication
Submission
Review
Copyediting
Production
Submission Files
Search
33643
irdalisa_1983, 2023_NEW Template_JPPIPA (1).docx
December 19, 2023
Article Text
Download All Files
Pre-Review Discussions
Add discussion
Name
From
Last Reply
Replies
Closed
No Items


jppipa.unram.ac.id/index.php/jppipa/authorDashboard/submission/6764
Jurnal Penelitian Pendidikan IPA
← Back to Submissions
Workflow
Publication
Submission
Review
Copyediting
Production
Round 1
Reviewer's Attachments
Search
No Files
Revisions
Search
Upload File
38114
LAYOUT FINAL_6764 (1).docx
April 14, 2024
Article Text
Review Discussions
Add discussion
Name
From
Last Reply
Replies
Closed
No Items
https://jppipa.unram.ac.id/index.php/jppipa/$$$call$$$/tab/author-dashboard/author-dashboard-tab/fetch-tab?submissionId=6764&stageId=3

HASIL REVIEW

JPPIPA 9(1) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Ricosre Model With Question Formulation Technique (QFT): Enhancing Students' Higher Order Thinking Skills (HOTS) and science literacy

Irdalisa[1*], Budhi Akbar[2], Tuti Marjan Fuadi[3], Maesaroh[4], Eka Kartikawati[5]

[1,2,4] Departement of Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Prof. DR. HAMKA, Jakarta, Indonesia.

[3] Departement of Biology Education, Faculty of Teacher Training and Education, Universitas Abulyatama, Aceh

Received:
Revised:
Accepted:
Published:

Corresponding Author:
Author Name*: Irdalisa
Email*: irdalisa@uhamka.ac.id

DOI:

Phone*: +62…

Abstract: **The 21st-century learning has undergone a paradigm shift in education from teacher-centered to student-centered. It recently emphasises students' critical and creative thinking abilities, effective communication, innovation, problem-solving, and collaboration. This study examined the Ricosre model's effectiveness with the Question Formulation Technique (QFT) in enhancing students' higher-order thinking skills (HOTS) and science literacy. It involved 296 fifth-grade students from three selected state elementary schools, chosen through cluster random sampling. Each group consisted of 148 students divided into control and experimental groups. Data were collected through multiple-choice and essay instruments and subsequently analysed using multivariate analysis of variance(MANOVA). The research variables were students' higher-order thinking skills (HOTS) and science literacy. The results indicated that the Ricosre model with QFT effectively improves students' higher-order thinking skills (HOTS) and science literacy, as it encouraged active participation during the learning process, trained students to develop questioning skills, find answers, analyse, share ideas, and draw conclusions. Thus, it can foster curiosity and metacognitive abilities among students.**

Keywords: Ricorse Model; QFT (Question Formulation Technique); Higher-Order Thingking Skills (HOTS); Science Literacy

Introduction

Innovations in technology influence human behavior in daily life. The conventional education system In the field of education, there is an increasing emphasis on teachers' multifaceted roles, extending beyond technical expertise. Besides possessing subject knowledge, they are expected to exhibit effective pedagogical skills, integrate technology awareness, and implement appropriate teaching strategies (Irdalisa et al., 2020). Teachers hold a pivotal position as influential agents in students' learning experiences, shaping their understanding of subject matter and nurturing their intrinsic motivation to learn (Ambusaidi et al., 2021). Students' thinking abilities will be more directed when they can express themselves, voice their opinions, solve problems independently and in groups, thus fostering social interaction among students (Prihatmojo et al., 2019). The success of students is determined by the skills and knowledge they use by adapting to every change in order to achieve mastery of 21st century skills (Hidayati et al., 2023).

High-order thinking skills (HOTS) entail students engaging in mental activities that critically and creatively connect, manipulate, and transform their existing knowledge and experiences. Through these cognitive processes, students can make informed

How to Cite:
Example: Susilawati, S., Doyan, A., Muliyadi, L., & Hakim, S. (2019). Growth of tin oxide thin film by aluminum and fluorine doping using spin coating Sol-Gel techniques. *Jurnal Penelitian Pendidikan IPA, 1*(1), 1-4. https://doi.org/10.29303/jppipa.v1i1.264

Commented [R1]: Tidak bold, justify

Commented [R2]: Ganti menjadi angka 1

Commented [R3]: Ganti menjadi angka 2

Commented [R4]: Ganti menjadi angka 1

Commented [R5]: Tidak bold

Commented [R6]: Ganti menjadi angka 1 atau 2, krna afiliasi nya hanya 2 tempat

Commented [R7]: 2, 4 dihapus

Commented [R8]: Ganti menjadi angka 2

Commented [R9]: superscritp

Commented [R10]: tidak bold

Commented [R11]: Diperlukan abstrak yang ringkas dan faktual (panjang maksimum 200 kata).
Abstrak harus menyatakan secara singkat tujuan, metode, hasil dan pembahasan, serta kesimpulan yang di narasikan secara ringkas

Commented [R12]: Urutkan keyword sesuai abjad,

Commented [R13]: Enter 1x

Commented [R14]: Indent 0,7 cm untuk baris pertama disetiap paragraf, cek dan perbaiki yang lainnnya dengan kesalahan yang sama

Commented [R15]: cocokkan referensi yang ada di naskah dengan yang di daftar referensi bawah,,disarankan menggunakan zotero, gunakan dan aktifkan DOI nya didalam artikel ini, APA style, cek dan perbaiki yang lainnnya dengan kesalahan yang sama

decisions (Dinni, 2018). Furthermore, HOTS empower students to analyse, evaluate, and innovate when addressing challenges within their environment (Ichsan et al., 2019). However, field observations reveal a limited range of strategies teachers employ to cultivate students' thinking abilities (Indriyana & Kuswandono, 2019). Students are often directed to comprehend and memorize the subject matter, resulting in a deficiency in their higher-order thinking skills. This challenge poses an issue that educators must address in the teaching process. Another contributing factor is teachers' insufficient knowledge of HOTS; not all educators possess a comprehensive understanding of it, and they may struggle to select appropriate methods and instructional models to enhance it (Afifah & Retnawati, 2019). Thus, addressing these issues requires a concerted effort from teachers and the education community to bolster students' HOTS and promote effective learning strategies.

HOTS is influenced by individual literacy capabilities (Indriyana & Kuswandono, 2019). There are five steps to enhance HOTS through literacy: setting learning objectives for reading in the classroom, engaging students in interactive questioning, instructing them to practice reviewing and improving comprehension, providing feedback, and assessing their learning progress (Indriyana & Kuswandono, 2019). However, Indonesia consistently ranks at the lowest level regarding science literacy (Chasanah et al., 2022). According to the Programme for International Student Assessment (PISA), science literacy among Indonesian students remains below the international average (Winarni et al., 2020). In 2012, Indonesia ranked 64th out of 65 countries with a score of 382. Subsequently 2015, it ranked 64th from 72 participating countries, scoring 403. These survey results indicate that science literacy among Indonesian students falls significantly below the international standard set by the organization (OECD, 2016). PISA's assessment places Indonesia's science literacy at the lowest rank among 64 countries (Rusilowati et al., 2016). This finding highlights Indonesian students' low science literacy level (Azrai et al., 2020).

Science literacy plays a crucial role in applying knowledge and skills among students, as it encourages active participation in constructing knowledge, reflecting on experiences, analyzing the real world, enhancing social negotiation, learning effective communication, and integrating learning experiences (Setyowati et al., 2022). Science literacy directs how science can serve as a solution for decision-making in addressing various issues. With science literacy capabilities, students can analyze, reason, and communicate effectively when confronted with problems, thus enabling them to solve and interpret challenges in diverse situations. Proficiency in science literacy equips students with the necessary skills to navigate real-life situations in the era of globalization (Winarni et al., 2020).

However, understanding science education that develops students' science literacy has not been entirely effective (Adnan et al., 2021). Not all teachers can create effective learning environments that foster science literacy among students (Winarni et al., 2020). The challenges in education stem from the weaknesses in implementing the teaching and learning process by teachers in schools (Wahyu et al., 2020). Students are not accustomed to working on science problems using discourse, and the learning process remains conventional, primarily focused on conceptual mastery (Windyariani, S. Setiono., Sutisnawati., 2017) . Masalah lainnya hilangnya minat dan motivasi siswa dalam mempelajari sains, karena banyaknya kesulitan siswa dalam mempelajari sains yang disebabkan model pembelajaran yang digunakan guru bersifat abstrak dan tidak melibatkan langsung siswa sehingga sering terjadi kesalahpahaman (Windyariani, S. Setiono., Sutisnawati., 2017). The resolution of these issues is hoped to be addressed by teachers. As the key figures in achieving learning objectives, teachers should adopt appropriate instructional models to ensure students can learn effectively and efficiently (Muspawi et al., 2019).

The conventional teaching models need to be replaced with creative and innovative approaches (Irdalisa et al., 2023). The Ricosre instructional model has been extensively studied by researchers and proven effective in fostering critical thinking for students of diverse academic abilities (Mahanal et al., 2019), and problem-solving abilities (Putri et al., 2020). Built on the principles of constructivism, the Ricosre model promotes a more active and student-centered classroom environment, leading to increased interest and motivation in learning (Ahmad, 2016). The Ricosre instructional model follows a syntactical structure comprising the following steps: (1) Reading, (2) Identifying the problem, (3) Constructing the solution, (4) Solving the problem, (5) Reviewing the problem-solving process, and (6) Extending the problem-solving to related contexts (Mahanal & Zubaidah, 2017a).

However, combining Ricosre research with the Question Formulation Technique (QFT) is still relatively uncommon. QFT is a technique developed by the Right Question Institute, and several studies have reported its potential implementation as a learning strategy to enhance students' curiosity, engagement, problem-solving skills, and independent thinking. The QFT consists of six stages: (1) A Question Focus (Qfocus), (2) The rules for producing questions and Producing questions, (3) Categorizing questions, (4) Prioritizing questions, (5) Next steps, and (6) Reflection (Mahanal & Zubaidah, 2017a). Each stage of the QFT is designed to facilitate students in generating numerous questions

Commented [R16]: narasikan tanpa system penomoran 1), 2), cek dan perbaiki yang lainnnya dengan kesalahan yang sama

Commented [R17]: narasikan tanpa system penomoran 1), 2), cek dan perbaiki yang lainnnya dengan kesalahan yang sama

(Garibay et al., 2020), encouraging them to think more deeply about the questions they create, thereby promoting critical thinking and enhancing students' long-term comprehension.

Therefore, integrating Ricosre principles and the QFT technique can be an innovative instructional model. This model provides a framework for inquiry-based learning guided by students' questions. It is designed to facilitate students in problem-solving through the generation of questions, promoting divergent, convergent, and metacognitive thinking, thus empowering and developing students' higher-order thinking skills (HOTS) and scientific literacy. This study examines the Ricosre model's effectiveness with QFT in enhancing students' higher-order thinking skills (HOTS) and scientific literacy.

Literature Review

Ricosre Model

The Ricosre model is a problem-solving-based instructional approach that facilitates students' thinking skills in the 21st century. Developed by Mahanal and Zubaidah in 2017, the Ricosre model comprises six stages: 1) Reading, 2) Identifying the problem, 3) Constructing the solution, 4) Solving the problem, 5) Reviewing the solution, and 6) Extending the solution (Mahanal et al., 2019). Each stage of the Ricosre model encourages students to apply higher-order thinking. Through systematic and guided problem-solving exercises, the Ricosre instructional model actively engages students (Mahanal et al., 2022). The syntax of the Ricosre model is an extension of John Dewey's learning syntax and can be outlined as follows: 1) Reading, 2) Identifying the problem, 3) Constructing the solution, 4) Solving the problem, 5) Reviewing the problem solving, and 6) Extending the problem solving (Mahanal & Zubaidah, 2017a).

Ricosre syntax includes grouping students into heterogeneous teams to reduce the academic achievement gap between students with low and high academic abilities (Putri et al., 2020). Numerous researchers have reported on the potential of the Ricosre model to enhance various skills. The Ricosre instructional model can be implemented in education to improve creative thinking skills (Mahanal & Zubaidah, 2017a). Furthermore, it holds promise in enhancing students' scientific reasoning abilities across different academic level (Putri et al., 2020). Ricosre is a model that fosters the development of creative and critical thinking skills, encouraging students to engage in complex problem-solving (Sari et al., 2018). The Ricosre instructional model has the potential to enhance creative thinking skills among students with low academic abilities. Additionally, it effectively bridges the gap in critical thinking skills between high- and low-achieving students (Mahanal et al., 2019). Compared to inquiry-based approaches, Ricosre has demonstrated greater success in improving high school students' science literacy (Mawaddah et al., 2021). Furthermore, Ricosre has been reported to significantly enhance students' problem-solving skills compared to conventional instructional models (Manisa et al., 2020).

QFT (Question Formulation Technique)

Question Formulation Technique (QFT) is an approach that teaches individuals how to formulate their questions, thus shifting the role of the questioner to the students themselves. QFT is a process that instructs students to generate their questions, improve upon them, determine how to use their questions to guide their learning and reflect on what and how they have learned (Mannion, 2019). Developed by Luz Santana and Dan Rothstein of the Right Question Institute in Lawrence, MA, QFT is an instructional strategy that was first widely introduced in the field of education through the book "Make Just One Change: Teach Students to Ask Their Own Questions". The Question Formulation Technique (QFT) comprises several essential elements: 1) learners are presented with a Question Focus (QFocus), which serves as a cue to elicit questions; 2) learners work on improving their questions; 3) learners devise strategies for using the questions (prioritizing questions according to the QFocus); 4) learners reflect on what they have learned, how they learned it, and what they think differently after going through the process (Garibay et al., 2020).

Many researchers have reported the potential of implementing QFT as a learning strategy to enhance various skills. The implementation of QFT in engineering undergraduate programs stimulates students' curiosity and engagement. QFT encourages divergent thinking among high school students. Therefore, the formulation of questions is an essential skill that learners in the 21st century must develop to cultivate curiosity, problem-solving ability, and independent thinking (Garibay et al., 2020). Several studies have been conducted on Ricosre and QFT separately. However, no reports have yet explored the integration of Ricosre and QFT. Thus, the researchers aim to investigate the implementation of the Ricosre model with QFT in enhancing high-order thinking skills (HOTS) and scientific literacy among students.

The collaboration between the Ricosre model and the Question Formulation Technique (QFT) is still relatively rare in research. QFT is a technique developed by the Right Question Institute. Some studies have reported on the potential implementation of QFT as a learning strategy, showing its effectiveness in enhancing curiosity, student engagement, problem-solving skills, and independent thinking. QFT consists of six stages: (1) A Question Focus (QFocus), (2) The rules for producing question and Producing question, (3) Categorizing

Commented [R18]: tidal bold, italic

Commented [R20]: narasikan tanpa system penomoran 1), 2), cek dan perbaiki yang lainnnya dengan kesalahan yang sama

Commented [R19]: narasikan tanpa system penomoran 1), 2), cek dan perbaiki yang lainnnya dengan kesalahan yang sama

Question, (4) Prioritizing Question, (5) Next steps, and (6) Reflection (Agustini, 2017). Each stage of QFT is designed to facilitate students in generating multiple questions (Garibay et al., 2020), which helps them think more deeply about the questions they create, enhances critical thinking, and improves students' long-term understanding.

Hence, the integration of Ricosre principles and QFT technique can be seen as an innovative instructional model. This model provides a framework for inquiry-based learning guided by students' questions. It is designed to facilitate students in problem-solving through question formulation and trains them to think divergently, convergently, and metacognitively, thus empowering and developing their higher-order thinking skills (HOTS) and scientific literacy. The objective of this research is to examine the effectiveness of the Ricosre model with QFT (Question Formulation Technique) in enhancing students' higher-order thinking skills (HOTS) and scientific literacy. Therefore, the research question is focused on investigating the effectiveness of the Ricosre model with QFT in improving students' higher-order thinking skills and scientific literacy.

Method

This research belongs to a quasi-experiment using a pretest-posttest control group design. The researchers implemented the Ricosre model with the Question Formulation Technique (QFT) in the experimental group, while the control group received the Direct Instruction model. The sampling technique used was cluster random sampling, resulting in a sample size of 296 students, with 148 students in each control and experimental group. The assessment indicators for higher-order thinking skills (HOTS) and science literacy can be seen in Figure 1.

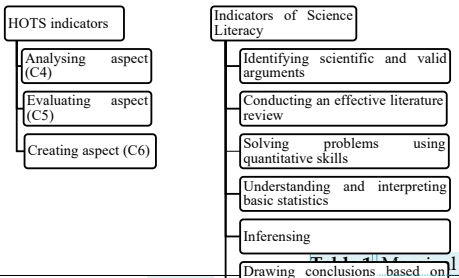


Figure 1: Indicators of Hots and Science Literacy Assessment

Multiple-choice questions were used to collect data on high-order thinking skills (HOTS), while essay questions were used to gather data on students' science literacy. Experts validated both the HOTS multiple-choice questions and the essay questions. The data on high-order thinking skills (HOTS) and science literacy from the students were used to test the proposed hypothesis that the implementation of the Ricosre model with QFT (Question Formulation Technique) was effective in enhancing high-order thinking skills (HOTS) and science literacy among the students. Multivariate analysis of variance (MANOVA) was utilized to test this hypothesis.

Result and Discussion

Results

The normality test results using the Kolmogorov-Smirnov test with a significance level of 5% indicated that the data followed a normal distribution (Saculinggan & Balase, 2013). Similarly, the results of the homogeneity test using the Barlett test showed that the samples used came from populations with equal variances. Based on the calculation of the Manova test with Wilk Lambda analysis, an F value of 933.976 was obtained with a significance value of 0.000 < 0.05. Furthermore, the tests of between-subject effects revealed that the relationship between Ricosre and QFT (Question Formulation Technique) used with HOTS resulted in an F value of 1452.109 with a significance value of 0.000, and the relationship between Ricosre and QFT (Question Formulation Technique) used with science literacy yielded an F value of 1775.217 with a significance value of 0.000. These findings indicate significant differences in students' HOTS and science literacy due to the variations of the instructional models.

The experimental class employed the Ricosre model with QFT, while the control class utilized the Direct Instruction teaching model. To determine the more effective instructional model, the marginal and cell means for each dependent variable were examined as presented in Table 1.

Table 1 Marginal and Cell Means

Class	Learning Model	Variable	Low	Moderate	High	Marginal Mean
Experiment			81,40	85,00	90,51	85,64

Commented [R21]: narasikan tanpa system penomoran 1), 2), cek dan perbaiki yang lainnnya dengan kesalahan yang sama

Commented [R23]: titik satu

Commented [R24]: justify, 9pt

Commented [R25]: harus jelas dan di sarankan ada alur/ chartnya.

Commented [R22]: Pertajam introduction ini, dengan menjelaskan apa novelty dari penelitian ini?
Berikan alasan2x yang logis mengapa penelitian ini penting dilakukan

Commented [R26]: tidak bold, italic

Commented [R27]: titik satu

Commented [R28]: justify

	Ricosre Model with QFT (Question Formulation Technique)	High-Order Thinking Skills (HOTS)				
		Science literacy	77,40	84,49	85,00	83,20
Control	Direct Instruction Model	High-Order Thinking Skills (HOTS)	62,60	65,00	71,63	66,41
		Science literacy	64,10	65,00	68,88	65,99
Marginal means		High-Order Thinking Skills (HOTS)	72,00	75,00	81,07	
		Science literacy	70,75	74,75	76,94	

Discussion

The marginal means of the variables "Higher Order Thinking Skills (HOTS)" and "Science Literacy" for the experimental class were higher compared to the control class. For the variable "Higher Order Thinking Skills (HOTS)," the mean score for students using the Ricosre model with QFT was 85.64, while for those using the Direct Instruction teaching model, it was 66.41. Thus, the average HOTS score with the Ricosre model and QFT was better than that with the Direct Instruction teaching model (Table 1). Similarly, for the variable "Science Literacy," the mean score for students using the Ricosre model with QFT was 83.20, while for those using the Direct Instruction teaching model, it was 65.99. Hence, the average Science Literacy score with the Ricosre model and QFT was superior to that with the Direct Instruction teaching model. Based on these findings, it can be concluded that students' Higher Order Thinking Skills (HOTS) and Science Literacy were better when using the Ricosre model with QFT than the Direct Instruction teaching model.

The Ricosre model with QFT proves effective in enhancing higher-order thinking skills as it actively engages students in the learning process. This approach encourages students to think critically about problems, conduct experiments to find answers, analyse and interpret data, and discuss their findings to draw conclusions (Mairoza & Fitriza, 2021). The Ricosre model actively involves students, allowing them to contribute their ideas (Azizah et al., 2020). The integration of QFT (Question Formulation Technique) within the Ricosre model is particularly effective in fostering students' higher-order thinking skills and science literacy. The learning phases are designed to develop questioning skills through idea generation, categorisation, prioritisation, and group discussions. By employing this model, teachers can support students in developing their questioning, metacognitive, and interpersonal skills, enabling them to ask relevant questions and developing their curiosity and morivation to learn.

Combining the Ricosre model's learning syntax with QFT empowers students' higher-order thinking skills (HOTS) and science literacy. The "reading" phase in the Ricosre model enables students to comprehend a passage, activating prior knowledge and stimulating them to identify the problems presented by rearticulating the text. During this phase, students focus on formulating questions, categorising them, and prioritising them based on the reading material, thereby improving their reading concentration. Reading is a key strategy in empowering higher-order thinking skills as it assists students in acquiring new information and establishing connections between ideas (Duke & Pearson, 2004). Developing strong reading skills helps students progress academically and enhances their professionalism (Velásquez, 2020).

In the "Identifying the problem" phase, students can recognise issues and deepen their knowledge about a particular problem. Problem identification involves students to clarify unclear and unstructured problems and allow them to search for the required solution criteria (Mahanal & Zubaidah, 2017b). In the "Constructing the solution" phase, students identify and explore the problem to determine the strategies for forming the solution. During the "Solving the problem" phase, students implement strategies to resolve the problem. The selected solutions are based on considerations from previously chosen solutions. In the "Reviewing the problem-solving" phase, students reflect and reevaluate to ensure the selected information is accurate. Lastly, in the "Extending the problem solution" phase, students communicate the results of their discussions. Thus, the learning syntax of the Ricosre model with QFT is designed to activate higher-order thinking skills through problem-solving activities. Consequently, using the Ricosre model with QFT stimulates students to enhance their thinking abilities at higher levels, involving critical thinking skills in digesting various types of information and solving problems. It enables students to construct explanations and connect acquired information to make decisions.

Commented [R29]: coba lihat dan ikuti aturan tabel menurut JPPIPA.
tulisan didalam tabel tidak bold, tidak italic,
hanya ada 3 garis pada tabel,,2 garis diatas,1 garis dibawah,
size tulisan dalam tabel 9 pt, book antiqua, kapital diawal kata sja,
kolom pertama rata kiri, kolom berikutnya rata kanan,
jika ada angka yang berkoma, ganti koma dengan titik,
tulis 2 angka dibelakang titik.
Hapus kolom nomor, ganti bahasa indonesia dengan bahasa inggris.

Commented [R30]: tidak bold, italic

The Ricosre and QFT models also help students to develop important metacognitive skills in HOTS. It refers to the ability to reflect on one's own thinking processes as well as monitor and regulate one's learning. It indicates that Ricosre and QFT models are very suitable to help improve students' higher-order thinking skills. High-order thinking skills refer to students' cognitive process at a higher level of thinking, student skills are built through a process that encourages critical thinking, creative thinking and problem solving skills (Yosepha et al., 2023), extending beyond memorization and restating known information (Mairoza & Fitriza, 2021). These skills are crucial for students to master as they enable them to make decisions, present strong arguments, think broadly from various perspectives to respond to problems effectively, generate problem-solving ideas, and encourage active participation in discussions (Heong et al., 2012) . In the domain of analysing, which is a part of HOTS, students are presented with a case or phenomenon to classify information, determine relationships, distinguish causes and effects, and identify and connect elements within the information. In the evaluation domain, students can assess ideas and solutions and can accept or reject statements. In creating domain, students can draw general conclusions from a given concept or perspective on a particular matter.

Scientific literacy is the ability to understand scientific concepts and principles and think scientifically to solve daily problems (Chasanah et al., 2022). Measured scientific literacy consists of identifying valid scientific opinions, conducting effective literature searches, solving problems using quantitative skills, understanding and interpreting basic statistics, making predictive inferences, and drawing conclusions based on quantitative data. Scientific literacy is essential to instill among students in 21st-century learning (Nisa., Wiyanto, Woro Sumarni., 2021). The existence of scientific literacy can prevent someone from making mistakes in understanding some information (Sharon & Baram-Tsabari, 2020).

Conclusion

Based on the research findings, it can be concluded that the Ricosre model with QFT is effective in enhancing students' HOTS and science literacy. Students who were given the Ricosre learning model and Question Formulation Technique (QFT) showed an increase in Higher-Order Thinking Skills (HOTS) and Science Literacy compared to using the direct introductory learning model. The combination of Ricosre and QFT is an innovative model in line with the demands of the 21st Century which requires learning with the 4C competencies of creativity, critical thinking, collaboration and communication.

Acknowledgments

We would like to thank Unit Pembina dan Pengembangan Peublikasi Ilmiah (UPPI) and Lemlitbang Universitas Muhammadiyah Prof. Dr. Hamka for providing a research grant under the scheme of Major Reputable International Publication (PPIBU) with reference number: 859/F.03.07/2022.

Author Contributions

This article was prepared by five people, namely I,I, B,A, M,M, E,N, and E, K. All research members carried out each stage cooperatively until this article was completed

Funding

This research received no external funding

Conflicts of Interest

The authors declare no conflict of interest

References

Adnan, Mulbar, U., Sugiarti, & Bahri, A. (2021). Scientific literacy skills of students: Problem of biology teaching in junior high school in South Sulawesi, Indonesia. *International Journal of Instruction*, *14*(3), 847–860. https://doi.org/10.29333/iji.2021.14349a

Afifah, I. R. N., & Retnawati, H. (2019). Is it difficult to teach higher order thinking skills? *Journal of Physics: Conference Series*, *1320*(1). https://doi.org/10.1088/1742-6596/1320/1/012098

Agustini, F. (2017). Peningkatan kemampuan bertanya dan penguasaan konsep IPA melalui pendekatan Question Formulation Technique (QFT) [Increasing the ability to ask question and mastery of science concepts through the Question Formulation Technique (QFT) approach]. *Jurnal Penelitian Pendidikan*, *17*(1). https://doi.org/10.17509/jpp.v17i1.6633

Ahmad, A. mahmoud ahmad. (2016). *Learner-centered instruction in english education: reality and expectations*. *7*(1), 1–23.

Ambusaidi, I., Badiali, B., & Alkharousi, K. (2021). Examining how biology teachers' pedagogical beliefs shape the implementation of the omani reform-oriented curriculum. *Athens Journal of Education*, *8*(3), 263–304. https://doi.org/10.30958/aje.8-3-3

Azizah, N., Mahanal, S., Zubaidah, S., & Setiawan, D.

Commented [R33]: Author Contributions/ apa peran setiap author, ditulis inisialnya, Contohnya (Gunakan inisial nama): contohnya:
Conceptualization, C. H. S. A, P. M. Z, T. R, R. A. E, M. N. S.; methodology, C. H. S. A.; validation, P. M. Z. and T. R.; formal analysis, R. A. E.; investigation, M. N. S., and C. H. S. A.; resources, P. M. Z. and T. R.; data curation, R. A. E.: writing—original draft preparation, M. N. S and C. H. S. A.; writing—review and editing, P. M. Z.: visualization, and T. R.and R. A. E. All authors have read and agreed to the published version of the manuscript.

Commented [R31]: tabel, gambar penelitian, gambar data harus lebih jelas dan tidak boleh hasil scan, harus ada literatur pendukung yg menguatkan hasil penelitian.

Commented [R32]: harus sesuai dengan ringkasan pd abstract, Kesimpulan utama penelitian ditulis dalam bagian Kesimpulan singkat

(2020). The effect of RICOSRE on students' critical thinking skills in biology. *AIP Conference Proceedings*, *2215*(April). https://doi.org/10.1063/5.0000562

Azrai, E. P., Suryanda, A.-, Wulaningsih, R. D., & Sumiyati, U. K. (2020). Kemampuan berpikir kritis dan literasi sains siswa SMA di Jakarta Timur [Critical thinking skills and scientific literacy of high school student in East Jakarta]. *Edusains*, *12*(1), 89–97. https://doi.org/10.15408/es.v12i1.13671

Chasanah, N., Widodo, W., & Suprapto, N. (2022). Pengembangan Instrumen Asesmen Literasi Sains Untuk Mendeskripsikan Profil Peserta Didik [Development of a science literacy assessment instrument to describe student profiles]. *PENDIPA Journal of Science Education*, *6*(2), 474–483. https://doi.org/10.33369/pendipa.6.2.474-483

Dinni, H. N. (2018). HOTS (High Order Thinking Skills) dan kaitannya dengan kemampuan literasi matematika [HOTS (High Order Thinking Skill) and its relation to mathematical literacy ability]. *PRISMA, Prosiding Seminar Nasional Matematika*, *1*, 170–176. https://journal.unnes.ac.id/sju/index.php/prisma/article/view/19597

Duke, N. K., & Pearson, P. D. (2004). *Effective Practices for Developing Reading Comprehension*. 205–242. https://doi.org/10.1598/0872071774.10

Garibay, C. T., Kerby, J., & Minigan, A. P. (2020). Implementation of the question formulation technique as a teaching strategy in renewable energy engineering education. *ASEE Annual Conference and Exposition, Conference Proceedings*, *2020-June*. https://doi.org/10.18260/1-2--34777

Heong, Y. M., Yunos, J. M., Othman, W., Hassan, R., Kiong, T. T., & Mohamad, M. M. (2012). The Needs Analysis of Learning Higher Order Thinking Skills for Generating Ideas. *Procedia - Social and Behavioral Sciences*, *59*(October), 197–203. https://doi.org/10.1016/j.sbspro.2012.09.265

Hidayati, N., Zubaidah, S., & Amnah, S. (2023). Effective learning model bases problem based learning and digital mind maps to improve student's collaboration skills. *International Journal of Evaluation and Research in Education*, *12*(3), 1307–1314. https://doi.org/10.11591/ijere.v12i3.22654

Ichsan, I. Z., Sigit, D. V., Miarsyah, M., Ali, A., Arif, W. P., & Prayitno, T. A. (2019). HOTS-AEP: Higher order thinking skills from elementary to master students in environmental learning. *European Journal of Educational Research*, *8*(4), 935–942. https://doi.org/10.12973/eu-jer.8.4.935

Indriyana, B. S., & Kuswandono, P. (2019). Developing Students' Higher Order Thinking Skills (HOTS) in Reading: English Teachers' Strategies in Selected Junior High Schools. *JET (Journal of English Teaching)*, *5*(3), 204. https://doi.org/10.33541/jet.v5i3.1313

Irdalisa, I., Amirullah, G., Hanum, E., Elvianasti, M., & Maesaroh, M. (2023). Developing STEAM-based students' worksheet with the ecoprint technique in biology subject. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *9*(1), 132. https://doi.org/10.33394/jk.v9i1.6775

Irdalisa, Paidi, & Djukri. (2020). Implementation of technology-based guided inquiry to improve tpack among prospective biology teachers. *International Journal of Instruction*, *13*(2), 33–44. https://doi.org/10.29333/iji.2020.1323a

Mahanal, S., & Zubaidah, S. (2017a). Model Pembelajaran Ricosre Yang Berpotensi Memberdayakan Keterampilan Berpikir Kreatif. *JUrnal Pendidikan*, *2*(5), 676–685. http://journal.um.ac.id/index.php/jptpp/

Mahanal, S., & Zubaidah, S. (2017b). Model pembelajaran ricosre yang berpotensi memberdayakan keterampilan berpikir kreatif [The ricosre learning model has the potential to empower creative thinking skills. *Jurnal Pendidikan*, *2*(5), 676–685. http://journal.um.ac.id/index.php/jptpp/

Mahanal, S., Zubaidah, S., Setiawan, D., Maghfiroh, H., & Muhaimin, F. G. (2022). Empowering College Students' Problem-Solving Skills through RICOSRE. *Education Sciences*, *12*(3). https://doi.org/10.3390/educsci12030196

Mahanal, S., Zubaidah, S., Sumiati, I. D., Sari, T. M., & Ismirawati, N. (2019). RICOSRE: A learning model to develop critical thinking skills for students with different academic abilities. *International Journal of Instruction*, *12*(2), 417–434. https://doi.org/10.29333/iji.2019.12227a

Mairoza, Y., & Fitriza, Z. (2021). Deskripsi Keterampilan Berpikir Tingkat Tinggi (HOTS) Peserta Didik Menggunakan Model Guided Inquiry Pada Materi Hukum Dasar Kimia [Description of student' Higher Order Thinking Skills (HOTS) using the guided inquiry model on basic chemical legal material. *Edukimia*, *3*(1), 078–083. https://doi.org/10.24036/ekj.v3.i1.a214

Manisa, T., Mahanal, S., & Rohman, F. (2020). Empowering problem-solving skills through RICOSRE learning model. *Jurnal Pendidikan Sains*, *8*(1), 12–15. https://doi.org/10.13140/RG.2.2.27283.20002

Mannion, J. M. (2019). The effectiveness of the question formulation technique on open-ended, written response questions in mathematics. *Rowan Thesis and Disertations*.

Mawaddah, K., Mahanal, S., Gofur, A., Setiawan, D., & Zubaidah, S. (2021). RICOSRE: An innovative

learning model to promote scientific literacy. *AIP Conference Proceedings*, *2330*(March). https://doi.org/10.1063/5.0043303

Muspawi, M., Suratno, S., & Ridwan, R. (2019). Upaya Peningkatan Higher Order Thinking Skills (HOTS) Siswa Melalui Penerapan Model Inquiri di SMA Negeri 9 Tanjung Jabung Timur [Efforts to increase students' Higher Order Thinking Skills (HOTS) through the implemetation of the inquiry model at SMA Neger. *Jurnal Ilmiah Universitas Batanghari Jambi*, *19*(2), 208. https://doi.org/10.33087/jiubj.v19i2.653

Nisa., Wiyanto, Woro Sumarni., K. (2021). *Systematic literature review: science literacy and sets (science, environment, technology, and society)*. *13*(1), 74–82.

OECD. (2016). Results from PISA 2015: Indonesia. In *OECD Publishing* (pp. 1–8). https://www.oecd.org/pisa/PISA-2015-Indonesia.pdf

Prihatmojo, A., Mulia Agustin, I., Ernawati, D., & Indriyani, D. (2019). Implementasi pendidikan karakter di abad 21 [Implementation of character education in the 21st century]. *Seminar Nasional Pendidikan. Fakultas Ilmu Pendidikan. Universitas Muhammadiyah Jakarta.*, 186. https://jurnal.umj.ac.id/index.php/SEMNASFIP/index

Putri, R. R., Mahanal, S., & Rohman, F. (2020). The Potential of RICOSRE in Improving Scientific Reasoning of Students with Different Academic Ability. *Jurnal Pendidikan Sains*, *8*(1), 16–21. http://journal.um.ac.id/index.php/jpsISSN:2338-9117

Rusilowati, A., Kurniawati, L., Nugroho, S. E., & Widiyatmoko, A. (2016). Developing an instrument of scientific literacy asessment on the cycle theme. *International Journal of Environmental and Science Education*, *11*(12), 5718–5727.

Saculinggan, M., & Balase, E. A. (2013). Empirical power comparison of goodness of fit tests for normality in the presence of outliers. *Journal of Physics: Conference Series*, *435*(1). https://doi.org/10.1088/1742-6596/435/1/012041

Sari, T. M., Mahanal, S., & Zubaidah, S. (2018). Empowering Critical Thinking with Ricosre Learning Model. *Jurnal Pendidikan Sains*, *6*(1), 1–5. http://journal.um.ac.id/index.php/jps/

Setyowati, A. P., Gunarhadi, G., & Musadad, A. A. (2022). Profile and Factors Influencing Students' Scientific Literacy. *Journal of International Conference Proceedings*, *5*(1), 314–323. https://doi.org/10.32535/jicp.v5i1.1481

Sharon, A. J., & Baram-Tsabari, A. (2020). Can science literacy help individuals identify misinformation in everyday life? *Science Education*, *104*(5), 873–894. https://doi.org/10.1002/sce.21581

Velásquez, E. (2020). The effect of discipline-related knowledge on heritage language learners' reading comprehension. *Athens Journal of Education*, *7*(1), 31–48. https://doi.org/10.30958/aje.7-1-2

Wahyu, Y., Suastra, I. W., Sadia, I. W., & Suarni, N. K. (2020). The effectiveness of mobile augmented reality assisted STEM-based learning on scientific literacy and students' achievement. *International Journal of Instruction*, *13*(3), 343–356. https://doi.org/10.29333/iji.2020.13324a

Winarni, E. W., Hambali, D., & Purwandari, E. P. (2020). Analysis of language and scientific literacy skills for 4th grade elementary school students through discovery learning and ict media. *International Journal of Instruction*, *13*(2), 213–222. https://doi.org/10.29333/iji.2020.13215a

Windyariani, S. Setiono., Sutisnawati., S. (2017). *Pengembangan model asesmen literasi sains berbasis konteks bagi siswa sekolah dasar [Development of a context-based scientific literacy assessment model for elementary school students]*. *1*, 633–640. http://publikasiilmiah.ums.ac.id/bitstream/handle/11617/9613.pdf/?sequence=1&isAllowed=y

Yosepha, A., Ali, M., Wahyudin, D., & Rusman. (2023). The Role of Multi-dimensional Curriculum Design in Improving Higher-Order Thinking Skills. *International Journal of Learning, Teaching and Educational Research*, *22*(7), 219–239. https://doi.org/10.26803/ijlter.22.7.12

Commented [R34]: Referensi belum cukup

Gunakan jurnal yang ada DOI

Minimal 40 sitasi/referensi
20 sitasi dari jurnal nasional terakreditasi
10 sitasi dari jurnal jppipa.unram.ac.id
10 sitasi dari jurnal internasional bereputasi scopus

Hasil penambahan sitasi masukkan di diskusi untuk memperkuat hasil penelitian

Daftar Pustaka APA (American Psychological Association Style)
Nama belakang pengarang diikuti oleh inisial nama depan.
Tahun penerbitan buku (dalam tanda kurung).
Judul buku (dicetak miring).
Edisi (dalam kurung bulat), jika selain yang pertama.
Kota penerbit.
Nama penerbit.
Doi.

Penulisan referensi menggunakan format APA, contoh:
Afriana, J., Permanasari, A., & Fitriani, A. (2016). Project based learning integrated to stem to enhance elementary school's students scientific literacy. Jurnal Pendidikan IPA Indonesia, 5(2), 261–267. https://doi.org/10.15294/jpii.v5i2.5493

Commented [R35]: Indent 0,7 cm untuk baris kedua dan seterusnya pada masing-masing referensi, cek dan perbaiki yang lainnnya dengan kesalahan yang sama

JPPIPA 10(3) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Ricosre Model with Question Formulation Technique (QFT): Enhancing Students' Higher Order Thinking Skills (HOTS) and Science Literacy

Irdalisa[1*], Budhi Akbar[1], Tuti Marjan Fuadi[2], Maesaroh[2], Eka Kartikawati[2]

[1] Department of Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Prof. DR. HAMKA, Jakarta, Indonesia.

[2] Department of Biology Education, Faculty of Teacher Training and Education, Universitas Abulyatama, Aceh, Indonesia.

Received: December 29, 2023
Revised: February 2, 2024
Accepted: March 25, 2024
Published: March 31, 2024

Corresponding Author:
Irdalisa
irdalisa@uhamka.ac.id

DOI: 10.29303/jppipa.v10i3.6764

Abstract: The 21st-century learning has undergone a paradigm shift in education from teacher-centered to student-centered. It recently emphasises students' critical and creative thinking abilities, effective communication, innovation, problem-solving, and collaboration. This study examined the Ricosre model's effectiveness with the Question Formulation Technique (QFT) in enhancing students' higher-order thinking skills (HOTS) and science literacy. It involved 296 fifth-grade students from three selected state elementary schools, chosen through cluster random sampling. Each group consisted of 148 students divided into control and experimental groups. Data were collected through multiple-choice and essay instruments and subsequently analysed using multivariate analysis of variance (MANOVA). The research variables were students' higher-order thinking skills (HOTS) and science literacy. The results indicated that the Ricosre model with QFT effectively improves students' higher-order thinking skills (HOTS) and science literacy, as it encouraged active participation during the learning process, trained students to develop questioning skills, find answers, analyse, share ideas, and draw conclusions. Thus, it can foster curiosity and metacognitive abilities among students.

Keywords: Higher-order thinking skills (HOTS); Question formulation technique (QFT); Ricorse model; Science literacy

Introduction

Innovations in technology influence human behavior in daily life. The conventional education system in the field of education, there is an increasing emphasis on teachers' multifaceted roles, extending beyond technical expertise. Besides possessing subject knowledge, they are expected to exhibit effective pedagogical skills, integrate technology awareness, and implement appropriate teaching strategies (Hidayati et al., 2016; Irdalisa et al., 2020). Teachers hold a pivotal position as influential agents in students' learning experiences, shaping their understanding of subject matter and nurturing their intrinsic motivation to learn (Ambusaidi et al., 2021). Students' thinking abilities will be more directed when they can express themselves, voice their opinions, solve problems independently and in groups, thus fostering social interaction among students (Prihatmojo et al., 2019). The success of students is determined by the skills and knowledge they use by adapting to every change in order to achieve mastery of 21st century skills (Hidayati et al., 2023).

High-order thinking skills (HOTS) entail students engaging in mental activities that critically and creatively connect, manipulate, and transform their existing knowledge and experiences. Through these cognitive processes, students can make informed decisions (Dinni, 2018). Furthermore, HOTS empower students to analyse, evaluate, and innovate when

How to Cite:
Irdalisa, Akbar, B., Fuadi, T. M., Maesaroh, & Kartikawati, E. (2024). Ricosre Model with Question Formulation Technique (QFT): Enhancing Students' Higher Order Thinking Skills (HOTS) and Science Literacy. *Jurnal Penelitian Pendidikan IPA*, *10*(3), 1175–1178. https://doi.org/10.29303/jppipa.v10i3.6764

addressing challenges within their environment (Ichsan et al., 2019). However, field observations reveal a limited range of strategies teachers employ to cultivate students' thinking abilities (Indriyana & Kuswandono, 2019). Students are often directed to comprehend and memorize the subject matter, resulting in a deficiency in their higher-order thinking skills. This challenge poses an issue that educators must address in the teaching process. Another contributing factor is teachers' insufficient knowledge of HOTS; not all educators possess a comprehensive understanding of it, and they may struggle to select appropriate methods and instructional models to enhance it (Afifah & Retnawati, 2019). Thus, addressing these issues requires a concerted effort from teachers and the education community to bolster students' HOTS and promote effective learning strategies.

HOTS is influenced by individual literacy capabilities (Indriyana & Kuswandono, 2019). There are five steps to enhance HOTS through literacy: setting learning objectives for reading in the classroom, engaging students in interactive questioning, instructing them to practice reviewing and improving comprehension, providing feedback, and assessing their learning progress (Indriyana & Kuswandono, 2019). However, Indonesia consistently ranks at the lowest level regarding science literacy (Chasanah et al., 2022). According to the Programme for International Student Assessment (PISA), science literacy among Indonesian students remains below the international average (Winarni et al., 2020). In 2012, Indonesia ranked 64th out of 65 countries with a score of 382. Subsequently 2015, it ranked 64th from 72 participating countries, scoring 403. These survey results indicate that science literacy among Indonesian students falls significantly below the international standard set by the organization (OECD, 2016). PISA's assessment places Indonesia's science literacy at the lowest rank among 64 countries (Rusilowati et al., 2016). This finding highlights Indonesian students' low science literacy level (Azrai et al., 2020).

Science literacy plays a crucial role in applying knowledge and skills among students, as it encourages active participation in constructing knowledge, reflecting on experiences, analyzing the real world, enhancing social negotiation, learning effective communication, and integrating learning experiences (Setyowati et al., 2022). Science literacy directs how science can serve as a solution for decision-making in addressing various issues. With science literacy capabilities, students can analyze, reason, and communicate effectively when confronted with problems, thus enabling them to solve and interpret challenges in diverse situations. Proficiency in science literacy equips students with the necessary skills to navigate real-life situations in the era of globalization (Winarni et al., 2020).

However, understanding science education that develops students' science literacy has not been entirely effective (Adnan et al., 2021). Not all teachers can create effective learning environments that foster science literacy among students (Winarni et al., 2020). The challenges in education stem from the weaknesses in implementing the teaching and learning process by teachers in schools (Wahyu et al., 2020). Students are not accustomed to working on science problems using discourse, and the learning process remains conventional, primarily focused on conceptual mastery (Windyariani et al., 2017). Another problem is the loss of student interest and motivation in studying science, due to the many difficulties students have in studying science due to the learning model used by teachers being abstract and not directly involving students so that misunderstandings often occur (Windyariani et al., 2017). The resolution of these issues is hoped to be addressed by teachers. As the key figures in achieving learning objectives, teachers should adopt appropriate instructional models to ensure students can learn effectively and efficiently (Muspawi et al., 2019).

The conventional teaching models need to be replaced with creative and innovative approaches (Irdalisa et al., 2023). The Ricosre instructional model has been extensively studied by researchers and proven effective in fostering critical thinking for students of diverse academic abilities (Mahanal et al., 2019), and problem-solving abilities (Putri et al., 2020). Built on the principles of constructivism, the Ricosre model promotes a more active and student-centered classroom environment, leading to increased interest and motivation in learning (Ahmad, 2016). The Ricosre instructional model follows a syntactical structure comprising the following steps: Reading, Identifying the problem, Constructing the solution, Solving the problem, Reviewing the problem-solving process, and Extending the problem-solving to related contexts (Mahanal et al., 2017).

However, combining Ricosre research with the Question Formulation Technique (QFT) is still relatively uncommon. QFT is a technique developed by the Right Question Institute, and several studies have reported its potential implementation as a learning strategy to enhance students' curiosity, engagement, problem-solving skills, and independent thinking. The QFT consists of six stages: A Question Focus (Qfocus), The rules for producing questions and Producing questions, Categorizing questions, Prioritizing questions, Next steps, and Reflection (Mahanal et al., 2017). Each stage of the QFT is designed to facilitate

students in generating numerous questions (Garibay et al., 2020), encouraging them to think more deeply about the questions they create, thereby promoting critical thinking and enhancing students' long-term comprehension.

Therefore, integrating Ricosre principles and the QFT technique can be an innovative instructional model. This model provides a framework for inquiry-based learning guided by students' questions. It is designed to facilitate students in problem-solving through the generation of questions, promoting divergent, convergent, and metacognitive thinking, thus empowering and developing students' higher-order thinking skills (HOTS) and scientific literacy. This study examines the Ricosre model's effectiveness with QFT in enhancing students' higher-order thinking skills (HOTS) and scientific literacy.

Method

This research belongs to a quasi-experiment using a pretest-posttest control group design. The researchers implemented the Ricosre model with the Question Formulation Technique (QFT) in the experimental group, while the control group received the Direct Instruction model. The sampling technique used was cluster random sampling, resulting in a sample size of 296 students, with 148 students in each control and experimental group. The assessment indicators for higher-order thinking skills (HOTS) and science literacy can be seen in Figure 1.

Multiple-choice questions were used to collect data on high-order thinking skills (HOTS), while essay questions were used to gather data on students' science literacy. Experts validated both the HOTS multiple-choice questions and the essay questions. The data on high-order thinking skills (HOTS) and science literacy from the students were used to test the proposed hypothesis that the implementation of the Ricosre model with QFT (Question Formulation Technique) was effective in enhancing high-order thinking skills (HOTS) and science literacy among the students. Multivariate analysis of variance (MANOVA) was utilized to test this hypothesis.

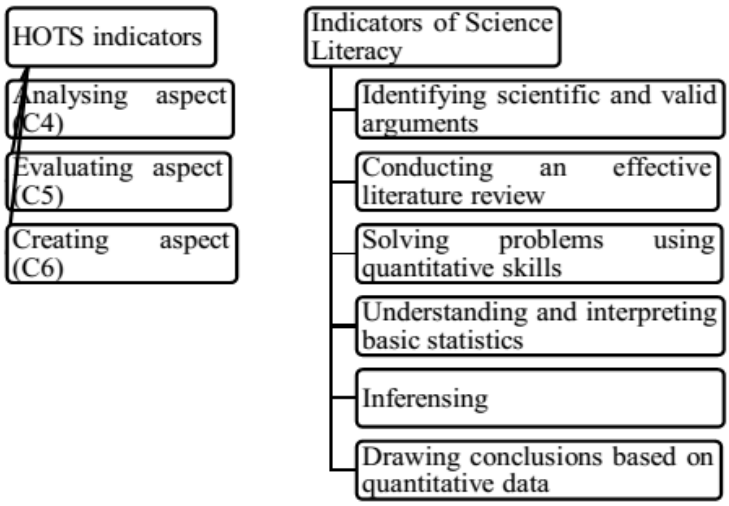


Figure 1. Indicators of HOTS and science literacy assessment

Result and Discussion

Results

The normality test results using the Kolmogorov-Smirnov test with a significance level of 5% indicated that the data followed a normal distribution (Saculinggan & Balase, 2013). Similarly, the results of the homogeneity test using the Barlett test showed that the samples used came from populations with equal variances. Based on the calculation of the Manova test with Wilk Lambda analysis, an F value of 933.976 was obtained with a significance value of 0.000 < 0.05. Furthermore, the tests of between-subject effects revealed that the relationship between Ricosre and QFT (Question Formulation Technique) used with HOTS resulted in an F value of 1452.109 with a significance value of 0.000, and the relationship between Ricosre and QFT (Question Formulation Technique) used with science literacy yielded an F value of 1775.217 with a significance value of 0.000. These findings indicate significant differences in students' HOTS and science literacy due to the variations of the instructional models.

Table 1. Marginal and Cell Means

Class	Learning Model	Dependent Variable	Low	Moderate	High	Marginal Mean
Experiment	Ricosre Model with QFT (Question Formulation Technique)	High-Order Thinking Skills (HOTS)	81.40	85.00	90.51	85.64
		Science literacy	77.40	84.49	85.00	83.20
Control	Direct Instruction Model	High-Order Thinking Skills (HOTS)	62.60	65.00	71.63	66.41
		Science literacy	64.10	65.00	68.88	65.99
Marginal means		High-Order Thinking Skills (HOTS)	72.00	75.00	81.07	
		Science literacy	70.75	74.75	76.94	

The experimental class employed the Ricosre model with QFT, while the control class utilized the Direct Instruction teaching model. To determine the more effective instructional model, the marginal and cell means for each dependent variable were examined as presented in Table 1.

Discussion

The marginal means of the variables "Higher Order Thinking Skills (HOTS)" and "Science Literacy" for the experimental class were higher compared to the control class. For the variable "Higher Order Thinking Skills (HOTS)," the mean score for students using the Ricosre model with QFT was 85.64, while for those using the Direct Instruction teaching model, it was 66.41. Thus, the average HOTS score with the Ricosre model and QFT was better than that with the Direct Instruction teaching model (Table 1). Similarly, for the variable "Science Literacy," the mean score for students using the Ricosre model with QFT was 83.20, while for those using the Direct Instruction teaching model, it was 65.99. Hence, the average Science Literacy score with the Ricosre model and QFT was superior to that with the Direct Instruction teaching model. Based on these findings, it can be concluded that students' Higher Order Thinking Skills (HOTS) and Science Literacy were better when using the Ricosre model with QFT than the Direct Instruction teaching model.

The Ricosre model with QFT proves effective in enhancing higher-order thinking skills as it actively engages students in the learning process. This approach encourages students to think critically about problems, conduct experiments to find answers, analyse and interpret data, and discuss their findings to draw conclusions (Mairoza & Fitriza, 2021). The Ricosre model actively involves students, allowing them to contribute their ideas (Azizah et al., 2020). The integration of QFT (Question Formulation Technique) within the Ricosre model is particularly effective in fostering students' higher-order thinking skills and science literacy. The learning phases are designed to develop questioning skills through idea generation, categorisation, prioritisation, and group discussions. By employing this model, teachers can support students in developing their questioning, metacognitive, and interpersonal skills, enabling them to ask relevant questions and developing their curiosity and morivation to learn.

Combining the Ricosre model's learning syntax with QFT empowers students' higher-order thinking skills (HOTS) and science literacy. The "reading" phase in the Ricosre model enables students to comprehend a passage, activating prior knowledge and stimulating them to identify the problems presented by rearticulating the text. During this phase, students focus on formulating questions, categorising them, and prioritising them based on the reading material, thereby improving their reading concentration. Reading is a key strategy in empowering higher-order thinking skills as it assists students in acquiring new information and establishing connections between ideas (Duke & Pearson, 2004). Developing strong reading skills helps students progress academically and enhances their professionalism (Velásquez, 2020).

In the "Identifying the problem" phase, students can recognise issues and deepen their knowledge about a particular problem. Problem identification involves students to clarify unclear and unstructured problems and allow them to search for the required solution criteria (Mahanal et al., 2017). In the "Constructing the solution" phase, students identify and explore the problem to determine the strategies for forming the solution. During the "Solving the problem" phase, students implement strategies to resolve the problem. The selected solutions are based on considerations from previously chosen solutions. In the "Reviewing the problem-solving" phase, students reflect and reevaluate to ensure the selected information is accurate. Lastly, in the "Extending the problem solution" phase, students communicate the results of their discussions. Thus, the learning syntax of the Ricosre model with QFT is designed to activate higher-order thinking skills through problem-solving activities. Consequently, using the Ricosre model with QFT stimulates students to enhance their thinking abilities at higher levels, involving critical thinking skills in digesting various types of information and solving problems. It enables students to construct explanations and connect acquired information to make decisions.

The Ricosre and QFT models also help students to develop important metacognitive skills in HOTS. It refers to the ability to reflect on one's own thinking processes as well as monitor and regulate one's learning. It indicates that Ricosre and QFT models are very suitable to help improve students' higher-order thinking skills. High-order thinking skills refer to students' cognitive process at a higher level of thinking, student skills are built through a process that encourages critical thinking, creative thinking and problem solving skills (Yosepha et al., 2023), extending beyond memorization and restating known information (Mairoza & Fitriza, 2021). These skills are crucial for students to master as they enable them to make decisions, present strong arguments, think broadly from various perspectives to respond to problems effectively, generate problem-solving ideas, and encourage active participation in discussions (Heong et al., 2012) . In the domain of analysing, which is a part of HOTS, students are presented with a case or phenomenon to classify information, determine relationships, distinguish causes and effects, and identify and connect elements within the information. In the evaluation domain, students can assess ideas and solutions and can accept or reject statements. In creating domain, students can draw general conclusions from a given concept or perspective on a particular matter.

Scientific literacy is the ability to understand scientific concepts and principles and think scientifically to solve daily problems (Chasanah et al., 2022). Measured scientific literacy consists of identifying valid scientific opinions, conducting effective literature searches, solving problems using quantitative skills, understanding and interpreting basic statistics, making predictive inferences, and drawing conclusions based on quantitative data. Scientific literacy is essential to instill among students in 21st-century learning (Nisa et al., 2021). The existence of scientific literacy can prevent someone from making mistakes in understanding some information (Sharon & Baram-Tsabari, 2020).

Conclusion

Based on the research findings, it can be concluded that the Ricosre model with QFT is effective in enhancing students' HOTS and science literacy. Students who were given the Ricosre learning model and Question Formulation Technique (QFT) showed an increase in Higher-Order Thinking Skills (HOTS) and Science Literacy compared to using the direct introductory learning model. The combination of Ricosre and QFT is an innovative model in line with the demands of the 21st Century which requires learning with the 4C competencies of creativity, critical thinking, collaboration and communication.

Acknowledgments
We would like to thank Unit Pembina dan Pengembangan Peublikasi Ilmiah (UPPI) and Lemlitbang Universitas Muhammadiyah Prof. Dr. Hamka for providing a research grant under the scheme of Major Reputable International Publication (PPIBU) with reference number: 859/F.03.07/2022.

Author Contributions
This article was prepared by five people, namely I,I, B,A, M,M, E,N, and E, K. I,I, B,A, M,M, E,N, and E, K have read and approved the published version of the manuscript.
All research members carried out each stage cooperatively until this article was completed.

Funding
This research received no external funding.

Conflicts of Interest
The authors declare no conflict of interest.

References

Adnan, Mulbar, U., Sugiarti, & Bahri, A. (2021). Scientific literacy skills of students: Problem of biology teaching in junior high school in South Sulawesi, Indonesia. *International Journal of Instruction*, *14*(3), 847–860. https://doi.org/10.29333/iji.2021.14349a

Afifah, I. R. N., & Retnawati, H. (2019). Is it difficult to teach higher order thinking skills? *Journal of Physics: Conference Series*, *1320*(1). https://doi.org/10.1088/1742-6596/1320/1/012098

Agustini, F. (2017). Peningkatan kemampuan bertanya dan penguasaan konsep IPA melalui pendekatan Question Formulation Technique (QFT) [Increasing the ability to ask question and mastery of science concepts through the Question Formulation Technique (QFT) approach]. *Jurnal Penelitian Pendidikan*, *17*(1). https://doi.org/10.17509/jpp.v17i1.6633

Ahmad, A. M. (2016). Learner-centered instruction in English education: Reality and expectations. *Arab World English Journal (AWEJ), 7*. https://dx.doi.org/10.2139/ssrn.2804001

Ambusaidi, I., Badiali, B., & Alkharousi, K. (2021). Examining how biology teachers' pedagogical beliefs shape the implementation of the omani reform-oriented curriculum. *Athens Journal of Education*, *8*(3), 263–304. https://doi.org/10.30958/aje.8-3-3

Azizah, N., Mahanal, S., Zubaidah, S., & Setiawan, D. (2020). The effect of RICOSRE on students' critical thinking skills in biology. *AIP Conference Proceedings*, *2215*(April). https://doi.org/10.1063/5.0000562

Azrai, E. P., Suryanda, A., Wulaningsih, R. D., & Sumiyati, U. K. (2020). Kemampuan berpikir kritis dan literasi sains siswa SMA di Jakarta Timur [Critical thinking skills and scientific literacy of high school student in East Jakarta]. *Edusains*, *12*(1), 89–97. https://doi.org/10.15408/es.v12i1.13671

Chasanah, N., Widodo, W., & Suprapto, N. (2022). Pengembangan Instrumen Asesmen Literasi Sains Untuk Mendeskripsikan Profil Peserta Didik [Development of a science literacy assessment instrument to describe student profiles]. *PENDIPA Journal of Science Education*, *6*(2), 474–483. https://doi.org/10.33369/pendipa.6.2.474-483

Dinni, H. N. (2018). HOTS (High Order Thinking Skills) dan kaitannya dengan kemampuan literasi matematika [HOTS (High Order Thinking Skill) and its relation to mathematical literacy ability]. *PRISMA, Prosiding Seminar Nasional Matematika*, *1*, 170–176. Retrieved from https://journal.unnes.ac.id/sju/index.php/prisma/article/view/19597

Duke, N. K., & Pearson, P. D. (2009). Effective practices for developing reading comprehension. J*ournal of education, 189*(1-2), 107-122. https://doi.org/10.1598/0872071774.10

Garibay, C. T., Kerby, J., & Minigan, A. P. (2020). Implementation of the question formulation technique as a teaching strategy in renewable energy engineering education. *ASEE Annual Conference and Exposition, Conference Proceedings*, *2020-June*. https://doi.org/10.18260/1-2--34777

Heong, Y. M., Yunos, J. M., Othman, W., Hassan, R., Kiong, T. T., & Mohamad, M. M. (2012). The Needs Analysis of Learning Higher Order Thinking Skills for Generating Ideas. *Procedia - Social and Behavioral Sciences*, *59*(October), 197–203. https://doi.org/10.1016/j.sbspro.2012.09.265

Hidayati, N., Zubaidah, S., & Amnah, S. (2023). Effective learning model bases problem based learning and digital mind maps to improve student's collaboration skills. *International Journal of Evaluation and Research in Education*, *12*(3), 1307–1314. https://doi.org/10.11591/ijere.v12i3.22654

Hidayati, S. N., Sabtiawan, W. B., & Subekti, H. (2016). Pengembangan Instrumen Penilaian Otentik : Validitas Teoritis dan Kepraktisan. *Jurnal Penelitian Pendidikan IPA*, *1*(1), 22–26. https://doi.org/10.26740/jppipa.v1n1.p22-26

Ichsan, I. Z., Sigit, D. V., Miarsyah, M., Ali, A., Arif, W. P., & Prayitno, T. A. (2019). HOTS-AEP: Higher order thinking skills from elementary to master students in environmental learning. *European Journal of Educational Research*, *8*(4), 935–942. https://doi.org/10.12973/eu-jer.8.4.935

Indriyana, B. S., & Kuswandono, P. (2019). Developing Students' Higher Order Thinking Skills (HOTS) in Reading: English Teachers' Strategies in Selected Junior High Schools. *JET (Journal of English Teaching)*, *5*(3), 204. https://doi.org/10.33541/jet.v5i3.1313

Irdalisa, I., Amirullah, G., Hanum, E., Elvianasti, M., & Maesaroh, M. (2023). Developing STEAM-based students' worksheet with the ecoprint technique in biology subject. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *9*(1), 132. https://doi.org/10.33394/jk.v9i1.6775

Irdalisa, Paidi, & Djukri. (2020). Implementation of technology-based guided inquiry to improve tpack among prospective biology teachers. *International Journal of Instruction*, *13*(2), 33–44. https://doi.org/10.29333/iji.2020.1323a

Mahanal, S., & Zubaidah, S. (2017). Model pembelajaran ricosre yang berpotensi memberdayakan keterampilan berpikir kreatif [The ricosre learning model has the potential to empower creative thinking skills. *Jurnal Pendidikan*, *2*(5), 676–685. Retrieved from https://journal.um.ac.id/index.php/jptpp/article/view/9180

Mahanal, S., Zubaidah, S., Setiawan, D., Maghfiroh, H., & Muhaimin, F. G. (2022). Empowering College Students' Problem-Solving Skills through RICOSRE. *Education Sciences*, *12*(3). https://doi.org/10.3390/educsci12030196

Mahanal, S., Zubaidah, S., Sumiati, I. D., Sari, T. M., & Ismirawati, N. (2019). RICOSRE: A learning model to develop critical thinking skills for students with different academic abilities. *International Journal of Instruction*, *12*(2), 417–434. https://doi.org/10.29333/iji.2019.12227a

Mairoza, Y., & Fitriza, Z. (2021). Deskripsi Keterampilan Berpikir Tingkat Tinggi (HOTS) Peserta Didik Menggunakan Model Guided Inquiry Pada Materi Hukum Dasar Kimia [Description of student' Higher Order Thinking Skills (HOTS) using the guided inquiry model on basic chemical legal material. *Edukimia*, *3*(1), 078–083. https://doi.org/10.24036/ekj.v3.i1.a214

Manisa, T., Mahanal, S., & Rohman, F. (2020). Empowering problem-solving skills through RICOSRE learning model. *Jurnal Pendidikan Sains*, *8*(1), 12–15. https://doi.org/10.13140/RG.2.2.27283.20002

Mannion, J. M. (2019). The effectiveness of the question formulation technique on open-ended, written response questions in mathematics. *Rowan Thesis and Disertations*.

Mawaddah, K., Mahanal, S., Gofur, A., Setiawan, D., & Zubaidah, S. (2021). RICOSRE: An innovative learning model to promote scientific literacy. *AIP Conference Proceedings*, *2330*(March). https://doi.org/10.1063/5.0043303

Muspawi, M., Suratno, S., & Ridwan, R. (2019). Upaya Peningkatan Higher Order Thinking Skills (HOTS) Siswa Melalui Penerapan Model Inquiri di SMA Negeri 9 Tanjung Jabung Timur [Efforts to increase students' Higher Order Thinking Skills (HOTS) through the implemetation of the inquiry model at SMA Neger. *Jurnal Ilmiah Universitas Batanghari Jambi*, *19*(2), 208. https://doi.org/10.33087/jiubj.v19i2.653

Nisa, K., Wiyanto, W., & Sumarni, W. (2021). Sistematik literatur review: literasi sains dan sets (science, environment, technology, and society). *EDUSAINS,* *13*(1), 74-82. https://doi.org/10.15408/es.v13i1.18717

OECD. (2016). *Results from PISA 2015: Indonesia*. OECD Publishing.

Prihatmojo, A., Mulia Agustin, I., Ernawati, D., & Indriyani, D. (2019). Implementasi pendidikan karakter di abad 21 [Implementation of character education in the 21st century]. In *Seminar Nasional Pendidikan. Fakultas Ilmu Pendidikan. Universitas Muhammadiyah Jakarta*. Retrieved from https://jurnal.umj.ac.id/index.php/SEMNASFIP/article/view/5125

Putri, R. R., Mahanal, S., & Rohman, F. (2020). The Potential of RICOSRE in Improving Scientific Reasoning of Students with Different Academic Ability. *Jurnal Pendidikan Sains*, *8*(1), 16–21. Retrieved from http://journal.um.ac.id/index.php/jps/article/view/13659

Rusilowati, A., Kurniawati, L., Nugroho, S. E., & Widiyatmoko, A. (2016). Developing an instrument of scientific literacy asessment on the cycle theme. *International Journal of Environmental and Science Education*, *11*(12), 5718–5727. Retrieved from http://www.ijese.net/makale_indir/IJESE_736_article_57af271992c81.pdf

Saculinggan, M., & Balase, E. A. (2013). Empirical power comparison of goodness of fit tests for normality in the presence of outliers. *Journal of Physics: Conference Series*, *435*(1). https://doi.org/10.1088/1742-6596/435/1/012041

Sari, T. M., Mahanal, S., & Zubaidah, S. (2018). Empowering Critical Thinking with Ricosre Learning Model. *Jurnal Pendidikan Sains*, *6*(1), 1–5. Retrieved from http://journal.um.ac.id/index.php/jps/article/view/10648

Setyowati, A. P., Gunarhadi, G., & Musadad, A. A. (2022). Profile and Factors Influencing Students' Scientific Literacy. *Journal of International Conference Proceedings*, *5*(1), 314–323. https://doi.org/10.32535/jicp.v5i1.1481

Sharon, A. J., & Baram-Tsabari, A. (2020). Can science literacy help individuals identify misinformation in everyday life? *Science Education*, *104*(5), 873–894. https://doi.org/10.1002/sce.21581

Velásquez, E. (2020). The effect of discipline-related knowledge on heritage language learners' reading comprehension. *Athens Journal of Education*, *7*(1), 31–48. https://doi.org/10.30958/aje.7-1-2

Wahyu, Y., Suastra, I. W., Sadia, I. W., & Suarni, N. K. (2020). The effectiveness of mobile augmented reality assisted STEM-based learning on scientific literacy and students' achievement. *International Journal of Instruction*, *13*(3), 343–356. https://doi.org/10.29333/iji.2020.13324a

Winarni, E. W., Hambali, D., & Purwandari, E. P. (2020). Analysis of language and scientific literacy skills for 4th grade elementary school students through discovery learning and ict media. *International Journal of Instruction*, *13*(2), 213–222. https://doi.org/10.29333/iji.2020.13215a

Windyariani, S., Setiono, S., & Sutisnawati, A. (2017). Pengembangan model asesmen literasi sains berbasis konteks bagi siswa sekolah dasar. In *Prosiding Seminar Nasional Pendidikan Berkemajuan dan Menggembirakan (The Progressive & Fun Education Seminar) ke-2*. Retrieved from https://publikasiilmiah.ums.ac.id/xmlui/handle/11617/9565

Yosepha, A., Ali, M., Wahyudin, D., & Rusman. (2023). The Role of Multi-dimensional Curriculum Design in Improving Higher-Order Thinking Skills. *International Journal of Learning, Teaching and Educational Research*, *22*(7), 219–239. https://doi.org/10.26803/ijlter.22.7.12

Model Ricorse with QFT (Question Formulation Technique): Enhancing Students' Higher-Order Thinking Skills (HOTS) and Science Literacy

by Irdalisa Irdalisa

Submission date: 07-Aug-2023 11:29PM (UTC+0700)
Submission ID: 2142717197
File name: Inggris_ricorse.pdf (207.69K)
Word count: 3526
Character count: 21638

Model Ricorse with QFT (Question Formulation Technique): Enhancing Students' Higher-Order Thinking Skills (HOTS) and Science Literacy

Irdalisa, Budhi Akbar, Zulherman
Email: Irdalisa@uhamka.ac.id

Abstract

21st-century learning has undergone a paradigm shift in education from teacher-centered to student-centered. It recently emphasises students' critical and creative thinking abilities, effective communication, innovation, problem-solving, and collaboration. This study examined the Ricorse model's effectiveness with the Question Formulation Technique (QFT) in enhancing students' higher-order thinking skills (HOTS) and science literacy. It involved 296 fifth-grade students from three selected state elementary schools, chosen through cluster random sampling. Each group consisted of 148 students divided into control and experimental groups. Data were collected through multiple-choice and essay instruments and subsequently analysed using multivariate analysis of variance (MANOVA). The research variables were students' higher-order thinking skills (HOTS) and science literacy. The results indicated that the Ricorse model with QFT effectively improves students' higher-order thinking skills (HOTS) and science literacy, as it encouraged active participation during the learning process, trained students to develop questioning skills, find answers, analyse, share ideas, and draw conclusions. Thus, it can foster curiosity and metacognitive abilities among students.

Keywords: *Ricorse Model, QFT (Question Formulation Technique), higher-order thinking skills (HOTS), science literacy*

Introduction

In the field of education, there is an increasing emphasis on teachers' multifaceted roles, extending beyond technical expertise. Besides possessing subject knowledge, they are expected to exhibit effective pedagogical skills, integrate technology awareness, and implement appropriate teaching strategies (Irdalisa et al., 2020). Teachers hold a pivotal position as influential agents in students' learning experiences, shaping their understanding of subject matter and nurturing their intrinsic motivation to learn (Ambusaydi et al., 2021). Students' thinking abilities will be more directed when they can express themselves, voice their opinions, solve problems independently and in groups, thus fostering social interaction among students (Prihatmojo et al., 2019).

High-order thinking skills (HOTS) entail students engaging in mental activities that critically and creatively connect, manipulate, and transform their existing knowledge and experiences. Through these cognitive processes, students can make informed decisions (Dinni, 2018). Furthermore, HOTS empower students to analyse, evaluate, and innovate when addressing challenges within their environment (Ichsan et al., 2019). However, field observations reveal a limited range of strategies teachers employ to cultivate students' thinking abilities (Indriyana & Kuswandono, 2019). Students are often directed to comprehend and memorize the subject matter, resulting in a deficiency in their higher-order thinking skills. This challenge poses an issue that educators must address in the teaching process. Another contributing factor is teachers'

insufficient knowledge of HOTS; not all educators possess a comprehensive understanding of it, and they may struggle to select appropriate methods and instructional models to enhance it (Afifah & Retnawati, 2018). Thus, addressing these issues requires a concerted effort from teachers and the education community to bolster students' HOTS and promote effective learning strategies.

HOTS is influenced by individual literacy capabilities (Indriyana & Kuswandono, 2019). There are five steps to enhance HOTS through literacy: setting learning objectives for reading in the classroom, engaging students in interactive questioning, instructing them to practice reviewing and improving comprehension, providing feedback, and assessing their learning progress (Indriyana, 2019). However, Indonesia consistently ranks at the lowest level regarding science literacy (Chasanah et al., 2022). According to the Programme for International Student Assessment (PISA), science literacy among Indonesian students remains below the international average (Winarni et al., 2020). In 2012, Indonesia ranked 64th out of 65 countries with a score of 382. Subsequently 2015, it ranked 64th from 72 participating countries, scoring 403. These survey results indicate that science literacy among Indonesian students falls significantly below the international standard set by the organization (OECD, 2015). PISA's assessment places Indonesia's science literacy at the lowest rank among 64 countries (Rusilowati et al.). This finding highlights Indonesian students' low science literacy level (Azrai et al., 2020).

Science literacy plays a crucial role in applying knowledge and skills among students, as it encourages active participation in constructing knowledge, reflecting on experiences, analyzing the real world, enhancing social negotiation, learning effective communication, and integrating learning experiences (Setyowati et al., 2022). Science literacy directs how science can serve as a solution for decision-making in addressing various issues. With science literacy capabilities, students can analyze, reason, and communicate effectively when confronted with problems, thus enabling them to solve and interpret challenges in diverse situations. Proficiency in science literacy equips students with the necessary skills to navigate real-life situations in the era of globalization (Winarni et al., 2020).

However, understanding science education that develops students' science literacy has not been entirely effective (Adnan et al., 2021). Not all teachers can create effective learning environments that foster science literacy among students (Winarni et al., 2020). The challenges in education stem from the weaknesses in implementing the teaching and learning process by teachers in schools (Wahyu et al., 2020). Students are not accustomed to working on science problems using discourse, and the learning process remains conventional, primarily focused on conceptual mastery (Windiyariani et al., 2017). The resolution of these issues is hoped to be addressed by teachers. As the key figures in achieving learning objectives, teachers should adopt appropriate instructional models to ensure students can learn effectively and efficiently (Muspawi et al., 2019).

The conventional teaching models need to be replaced with creative and innovative approaches (Irdalisa et al., 2023). The Ricorse instructional model has been extensively studied by researchers and proven effective in fostering critical thinking for students of diverse academic abilities (Mahanal et al., 2019), analytical thinking skills (Diah et al., 2023), literacy skills (Fadhilah et al., 2023), problem-solving abilities (Putri et al., 2023), and enhancing students' critical thinking skills (Hardianto et al., 2023). Built on the principles of constructivism, the Ricorse model promotes a more active and student-centered classroom environment, leading to increased interest and motivation in

learning (Ahmad, 2016). The Ricorse instructional model follows a syntactical structure comprising the following steps: (1) Reading, (2) Identifying the problem, (3) Constructing the solution, (4) Solving the problem, (5) Reviewing the problem-solving process, and (6) Extending the problem-solving to related contexts (Mahanal and Zubaidah, 2017).

However, combining Ricorse research with the Question Formulation Technique (QFT) is still relatively uncommon. QFT is a technique developed by the Right Question Institute, and several studies have reported its potential implementation as a learning strategy to enhance students' curiosity, engagement, problem-solving skills, and independent thinking (Leblact et al., 2017; Minigan, 2017; Garibay et al., 2020). The QFT consists of six stages: (1) A Question Focus (Qfocus), (2) The rules for producing questions and Producing questions, (3) Categorizing questions, (4) Prioritizing questions, (5) Next steps, and (6) Reflection (Agustini and Sopandi, 2017). Each stage of the QFT is designed to facilitate students in generating numerous questions (Garibay, 2020), encouraging them to think more deeply about the questions they create, thereby promoting critical thinking and enhancing students' long-term comprehension (Nurhasanah, 2021).

Therefore, integrating Ricorse principles and the QFT technique can be an innovative instructional model. This model provides a framework for inquiry-based learning guided by students' questions. It is designed to facilitate students in problem-solving through the generation of questions, promoting divergent, convergent, and metacognitive thinking, thus empowering and developing students' higher-order thinking skills (HOTS) and scientific literacy. This study examines the Ricorse model's effectiveness with QFT in enhancing students' higher-order thinking skills (HOTS) and scientific literacy.

Literature Review

Ricorse Model

The Ricorse model is a problem-solving-based instructional approach that facilitates students' thinking skills in the 21st century. Developed by Mahanal and Zubaidah in 2017, the Ricorse model comprises six stages: 1) Reading, 2) Identifying the problem, 3) Constructing the solution, 4) Solving the problem, 5) Reviewing the solution, and 6) Extending the solution (Mahanal et al., 2019). Each stage of the Ricorse model encourages students to apply higher-order thinking. Through systematic and guided problem-solving exercises, the Ricorse instructional model actively engages students (Mahanal et al., 2022). The syntax of the Ricorse model is an extension of John Dewey's learning syntax and can be outlined as follows: 1) Reading, 2) Identifying the problem, 3) Constructing the solution, 4) Solving the problem, 5) Reviewing the problem solving, and 6) Extending the problem solving (Manahal and Zubaidah, 2017). Additionally, the Ricorse syntax includes grouping students into heterogeneous teams to reduce the academic achievement gap between students with low and high academic abilities (Putri et al., 2020). Numerous researchers have reported on the potential of the Ricorse model to enhance various skills. The Ricorse instructional model can be implemented in education to improve creative thinking skills (Mahanal and Zubaidah, 2017). Furthermore, it holds promise in enhancing students' scientific reasoning abilities

across different academic levels (Putri et al., 2020). Ricorse is a model that fosters the development of creative and critical thinking skills, encouraging students to engage in complex problem-solving (Sari et al., 2018). The Ricorse instructional model has the potential to enhance creative thinking skills among students with low academic abilities (Sumiati et al., 2018). Additionally, it effectively bridges the gap in critical thinking skills between high- and low-achieving students (Maharal et al., 2019). Compared to inquiry-based approaches, Ricorse has demonstrated greater success in improving high school students' science literacy (Mawaddah et al., 2021). Furthermore, Ricorse has been reported to significantly enhance students' problem-solving skills compared to conventional instructional models (Manisa et al., 2020).

QFT (Question Formulation Technique)

Question Formulation Technique (QFT) is an approach that teaches individuals how to formulate their questions, thus shifting the role of the questioner to the students themselves. QFT is a process that instructs students to generate their questions, improve upon them, determine how to use their questions to guide their learning and reflect on what and how they have learned (Mannion, 2019). Developed by Luz Santana and Dan Rothstein of the Right Question Institute in Lawrence, MA, QFT is an instructional strategy that was first widely introduced in the field of education through the book "Make Just One Change: Teach Students to Ask Their Own Questions" (Rothstein and Santana, 2011). The Question Formulation Technique (QFT) comprises several essential elements: 1) learners are presented with a Question Focus (QFocus), which serves as a cue to elicit questions; 2) learners work on improving their questions; 3) learners devise strategies for using the questions (prioritizing questions according to the QFocus); 4) learners reflect on what they have learned, how they learned it, and what they think differently after going through the process (Garibay et al., 2020).

Many researchers have reported the potential of implementing QFT as a learning strategy to enhance various skills. Leblanc et al. (2017) found that the implementation of QFT in engineering undergraduate programs stimulates students' curiosity and engagement. Similarly, Clark et al. (2019) observed that applying QFT encourages divergent thinking among high school students. Therefore, the formulation of questions is an essential skill that learners in the 21st century must develop to cultivate curiosity, problem-solving ability, and independent thinking (Minigan 2017; Garibay et al. 2020).

Several studies have been conducted on Ricorse and QFT separately. However, no reports have yet explored the integration of Ricorse and QFT. Thus, the researchers aim to investigate the implementation of the Ricorse model with QFT in enhancing high-order thinking skills (HOTS) and scientific literacy among students.

The collaboration between the Ricorse model and the Question Formulation Technique (QFT) is still relatively rare in research. QFT is a technique developed by the Right Question Institute. Some studies have reported on the potential implementation of QFT as a learning strategy, showing its effectiveness in enhancing curiosity, student engagement, problem-solving skills, and independent thinking (Leblanc et al. 2017; Minigan 2017; Garibay et al. 2020). QFT consists of six stages: (1) A Question Focus (QFocus), (2) The rules for producing question and Producing question, (3) Categorizing Question, (4) Prioritizing Question, (5) Next steps, and (6) Reflection (Agustini and Sopandi 2017). Each stage of QFT is designed to facilitate students in

generating multiple questions (Garibay 2020), which helps them think more deeply about the questions they create, enhances critical thinking, and improves students' long-term understanding (Nurhasanah 2021).

Hence, the integration of Ricorse principles and QFT technique can be seen as an innovative instructional model. This model provides a framework for inquiry-based learning guided by students' questions. It is designed to facilitate students in problem-solving through question formulation and trains them to think divergently, convergently, and metacognitively, thus empowering and developing their higher-order thinking skills (HOTS) and scientific literacy. The objective of this research is to examine the effectiveness of the Ricorse model with QFT (Question Formulation Technique) in enhancing students' higher-order thinking skills (HOTS) and scientific literacy. Therefore, the research question is focused on investigating the effectiveness of the Ricorse model with QFT in improving students' higher-order thinking skills and scientific literacy.

Methodology

This research belongs to a quasi-experiment using a pretest-posttest control group design. The researcher implemented the Ricorse model with the Question Formulation Technique (QFT) in the experimental group, while the control group received the Direct Instruction model. The sampling technique used was cluster random sampling, resulting in a sample size of 296 students, with 148 students in each control and experimental group. The assessment indicators for higher-order thinking skills (HOTS) and science literacy can be seen in Figure 1.

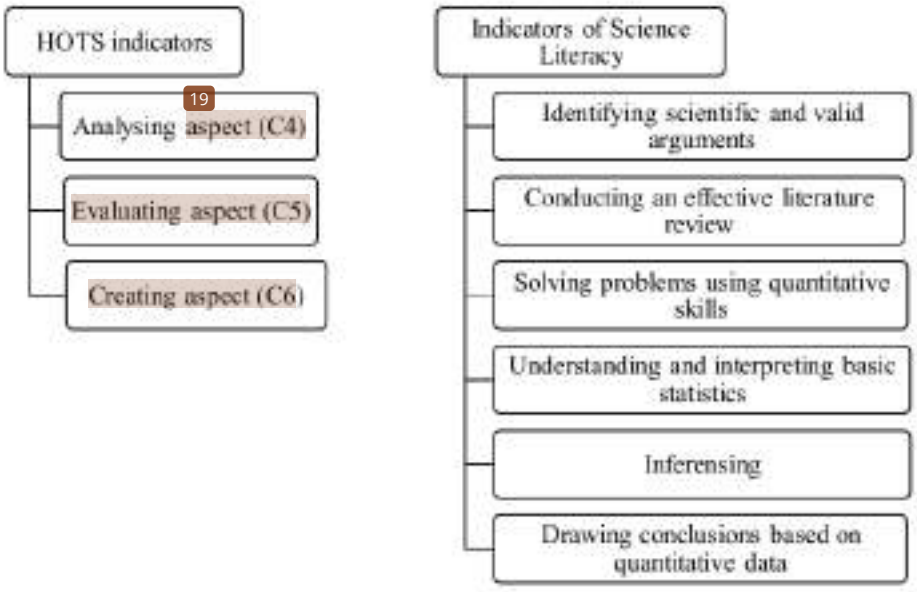


Figure 1. Indicators of HOTS and Science Literacy Assessment

Multiple-choice questions were used to collect data on high-order thinking skills (HOTS), while essay questions were used to gather data on students' science literacy. Experts validated both the HOTS multiple-choice questions and the essay questions. The data on high-order thinking skills (HOTS) and science literacy from the students were used to test the proposed hypothesis that the implementation of the Ricorse model with QFT (Question Formulation Technique) was effective in enhancing high-order thinking skills (HOTS) and science literacy among the students. Multivariate analysis of variance (MANOVA) was utilized to test this hypothesis.

Results

The normality test results using the Kolmogorov-Smirnov test with a significance level of 5% indicated that the data followed a normal distribution (Sculinggan 2013). Similarly, the results of the homogeneity test using the Barlett test showed that the samples used came from populations with equal variances. Based on the calculation of the Manova test with Wilk Lambda analysis, an F value of 933.976 was obtained with a significance value of 0.000 < 0.05. Furthermore, the tests of between-subject effects revealed that the relationship between Ricorse and QFT (Question Formulation Technique) used with HOTS resulted in an F value of 1452.109 with a significance value of 0.000, and the relationship between Ricorse and QFT (Question Formulation Technique) used with science literacy yielded an F value of 1775.217 with a significance value of 0.000. These findings indicate significant differences in students' HOTS and science literacy due to the variations of the instructional models.

The experimental class employed the Ricorse model with QFT, while the control class utilized the Direct Instruction teaching model. To determine the more effective instructional model, the marginal and cell means for each dependent variable were examined as presented in Table 1.

Table 1. Marginal and cell Means

Class	Learning Model	Dependent Variable	Low	Moderate	High	Marginal Mean
Experiment	Ricorse Model with QFT (Question Formulation Technique)	High-Order Thinking Skills (HOTS)	81,40	85,00	90,51	85,64
		Science literacy	77,40	84,49	85,00	83,20
Control	Direct Instruction	High-Order Thinking Skills (HOTS)	62,60	65,00	71,63	66,41

	Model	Science literacy	64,10	65,00	68,88	65,99
Marginal means		High-Order Thinking Skills (HOTS)	72,00	75,00	81,07	
		Science literacy	70,75	74,75	76,94	

Discussion

The marginal means of the variables "Higher Order Thinking Skills (HOTS)" and "Science Literacy" for the experimental class were higher compared to the control class. For the variable "Higher Order Thinking Skills (HOTS)," the mean score for students using the Ricorse model with QFT was 85.64, while for those using the Direct Instruction teaching model, it was 66.41. Thus, the average HOTS score with the Ricorse model and QFT was better than that with the Direct Instruction teaching model (Table 1). Similarly, for the variable "Science Literacy," the mean score for students using the Ricorse model with QFT was 83.20, while for those using the Direct Instruction teaching model, it was 65.99. Hence, the average Science Literacy score with the Ricorse model and QFT was superior to that with the Direct Instruction teaching model. Based on these findings, it can be concluded that students' Higher Order Thinking Skills (HOTS) and Science Literacy were better when using the Ricorse model with QFT than the Direct Instruction teaching model.

The Ricorse model with QFT proves effective in enhancing higher-order thinking skills as it actively engages students in the learning process. This approach encourages students to think critically about problems, conduct experiments to find answers, analyse and interpret data, and discuss their findings to draw conclusions (Mairoza and Fitriza, 2021). The Ricorse model actively involves students, allowing them to contribute their ideas (Azizah et al. 2020). The integration of QFT (Question Formulation Technique) within the Ricorse model is particularly effective in fostering students' higher-order thinking skills and science literacy. The learning phases are designed to develop questioning skills through idea generation, categorisation, prioritisation, and group discussions. By employing this model, teachers can support students in developing their questioning, metacognitive, and interpersonal skills, enabling them to ask relevant questions and developing their curiosity and motivation to learn.

Combining the Ricorse model's learning syntax with QFT empowers students' higher-order thinking skills (HOTS) and science literacy. The "reading" phase in the Ricorse model enables students to comprehend a passage, activating prior knowledge and stimulating them to identify the problems presented by rearticulating the text. During this phase, students focus on formulating questions, categorising them, and prioritising them based on the reading material, thereby improving their reading concentration. Reading is a key strategy in empowering higher-order thinking skills as it assists students in acquiring new information and establishing connections between ideas (Duke and Pearson 2002). Developing strong reading skills helps students progress academically and enhances their professionalism (Velásquez 2020).

In the "Identifying the problem" phase, students can recognise issues and deepen their knowledge about a particular problem. Problem identification involves students to clarify unclear and unstructured problems and allow them to search for the required solution criteria (Maluanl and Zubaidah 2017). In the "Constructing the solution" phase, students identify and explore the problem to determine the strategies for forming the solution. During the "Solving the problem" phase, students implement strategies to resolve the problem. The selected solutions are based on considerations from previously chosen solutions. In the "Reviewing the problem-solving" phase, students reflect and reevaluate to ensure the selected information is accurate. Lastly, in the "Extending the problem solution" phase, students communicate the results of their discussions. Thus, the learning syntax of the Ricorse model with QFT is designed to activate higher-order thinking skills through problem-solving activities. Consequently, using the Ricorse model with QFT stimulates students to enhance their thinking abilities at higher levels, involving critical thinking skills in digesting various types of information and solving problems. It enables students to construct explanations and connect acquired information to make decisions.

The Ricorse and QFT models also help students to develop important metacognitive skills in HOTS. It refers to the ability to reflect on one's own thinking processes as well as monitor and regulate on learning. It indicates that Ricorse and QFT models are very suitable to help improve students' higher-order thinking skills.

High-order thinking skills refer to students' cognitive process at a higher level of thinking, extending beyond memorization and restating known information (Mairoza and Fitriza 2021). These skills are crucial for students to master as they enable them to make decisions, present strong arguments, think broadly from various perspectives to respond to problems effectively, generate problem-solving ideas, and encourage active participation in discussions (Lestari 2017; Heong et al. 2012). In the domain of analysing, which is a part of HOTS, students are presented with a case or phenomenon to classify information, determine relationships, distinguish causes and effects, and identify and connect elements within the information. In the evaluation domain, students can assess ideas and solutions and can accept or reject statements. In creating domain, students can draw general conclusions from a given concept or perspective on a particular matter.

Scientific literacy is the ability to understand scientific concepts and principles and think scientifically to solve daily problems (Chasanah et al. 2022). Measured scientific literacy consists of identifying valid scientific opinions, conducting effective literature searches, solving problems using quantitative skills, understanding and interpreting basic statistics, making predictive inferences, and drawing conclusions based on quantitative data. Scientific literacy is essential to instill among students in 21st-century learning (Nisa et al. 2021). The existence of scientific literacy can prevent someone from making mistakes in understanding some information (Sharon and Tsabari 2020).

Conclusion

Based on the research findings, it can be concluded that the Ricorse model with QFT (Question Formulation Technique) is effective in enhancing students' high-order thinking skills (HOTS) and scientific literacy.

Acknowledgment

Model Ricorse with QFT (Question Formulation Technique): Enhancing Students' Higher-Order Thinking Skills (HOTS) and Science Literacy

ORIGINALITY REPORT

10%	8%	7%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	media.neliti.com Internet Source	1%
2	www.mdpi.com Internet Source	1%
3	www.emeraldinsight.com Internet Source	1%
4	repository.upi.edu Internet Source	1%
5	L Harisudin, Susanto, Hobri. "The development of mathematics learning tools through the bridge games based on lesson study for learning community and its relationship with the higherorder thinking skills in probability theory", Journal of Physics: Conference Series, 2019 Publication	1%
6	jurnal.stie-aas.ac.id Internet Source	1%

7	cainnovativeteaching.weebly.com Internet Source	1 %
8	www.researchgate.net Internet Source	<1 %
9	Adnan, U Mulbar, Sugiarti, A Bahri. "Biology Science Literacy of Junior High School Students in South Sulawesi, Indonesia", Journal of Physics: Conference Series, 2021 Publication	<1 %
10	Alberth Supriyanto Manurung, Abdul Halim, Ainur Rosyid. "The Role of Problem Based Learning Learning in Improving Student Character Education", Jurnal Basicedu, 2023 Publication	<1 %
11	Berti Yolida, Rini Rita T. Marpaung, Revi Handini. "Problem based learning model using vee diagrams on students' scientific literacy of environmental pollution material", JPBIO (Jurnal Pendidikan Biologi), 2021 Publication	<1 %
12	C A Wahyudhi, I W Muafa, M Awal, A R Kadir. "The effect of consumer behavior attitudes towards indhihome product purchasing decisions relating to the implementation of CRS (Corporate Social Responsibility) programs", IOP Conference Series: Earth and Environmental Science, 2019 Publication	<1 %

13	11mail.tech4learning.com Internet Source	<1 %
14	journal.student.uny.ac.id Internet Source	<1 %
15	moraref.kemenag.go.id Internet Source	<1 %
16	www.scribd.com Internet Source	<1 %
17	Hufri, S Y Sari, Desi Deswita, Risky Wahyuni. "Practicality and effectiveness of physics teaching materials based on contextual through inquiry to increase studentsscience literacy", Journal of Physics: Conference Series, 2019 Publication	<1 %
18	Nor Azizah, Susriyati Mahanal, Siti Zubaidah, Deny Setiawan. "The effect of RICOSRE on students' critical thinking skills in biology", AIP Publishing, 2020 Publication	<1 %
19	ejournal.unesa.ac.id Internet Source	<1 %
20	slideplayer.com Internet Source	<1 %

21	Susriyati Mahanal, Siti Zubaidah, Deny Setiawan, Hidayati Maghfiroh, Fahrul Ghani Muhaimin. "Empowering College Students' Problem-Solving Skills through RICOSRE", Education Sciences, 2022 Publication	<1%
22	Christina J. Rocha. "chapter 10 Inspiring Inquiry With the i2Flex Model in the World Language Classroom", IGI Global, 2021 Publication	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	Off		